Tropospheric Ozone Over the North Pacific During TRACE-P (February – April 2001) From Ozonesonde Observations

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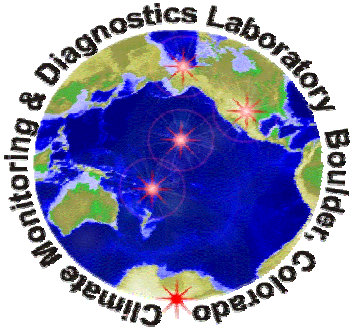


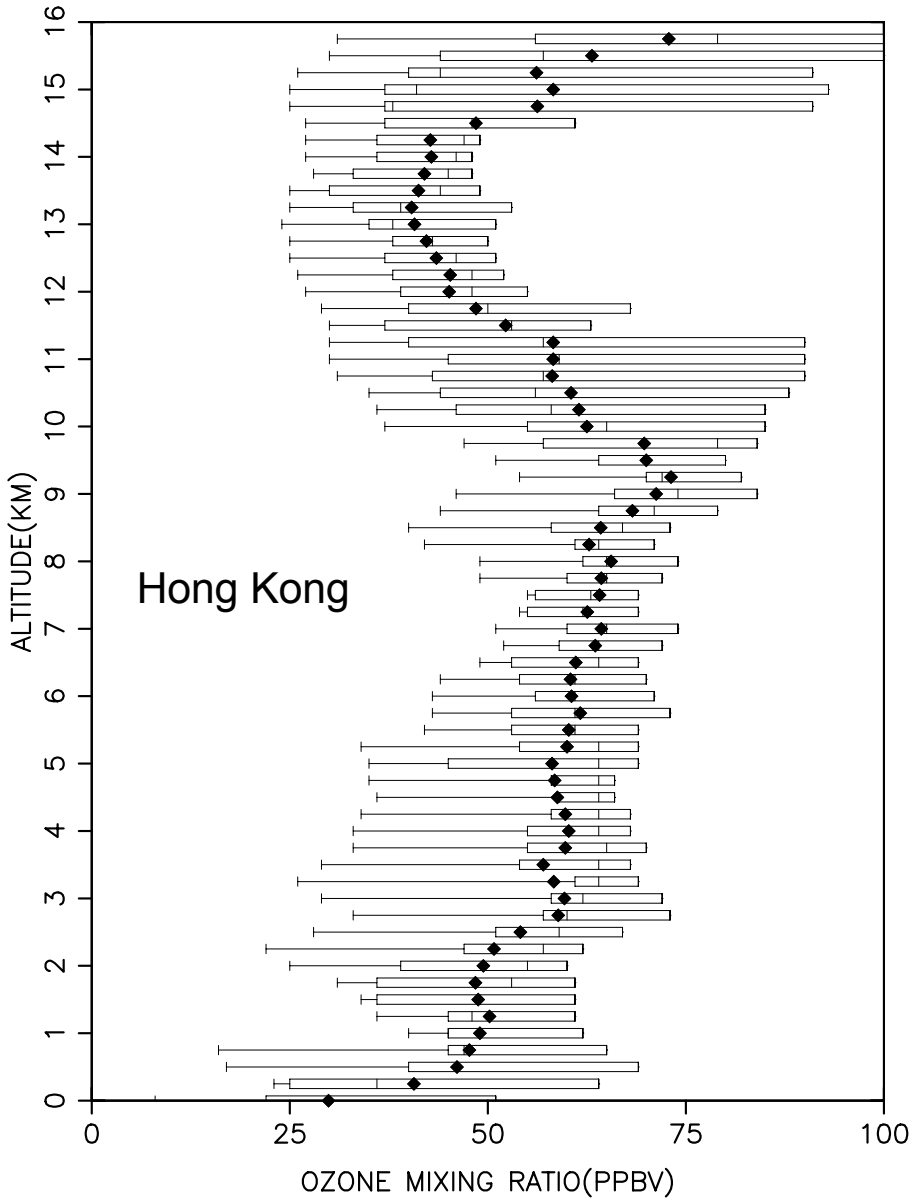
TRACE-P Data Workshop

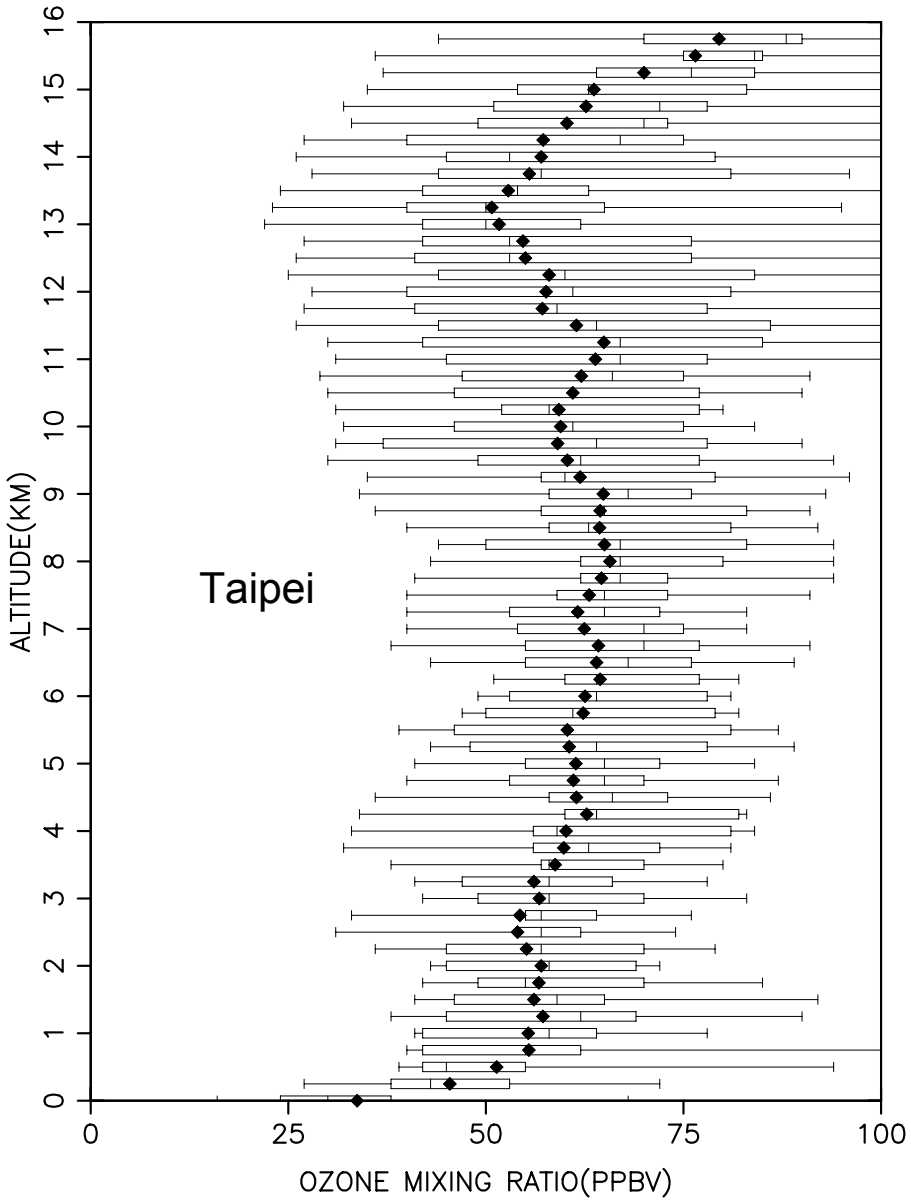
November 13-16, 2001

Ozonesonde Stations Operating During TRACE-P

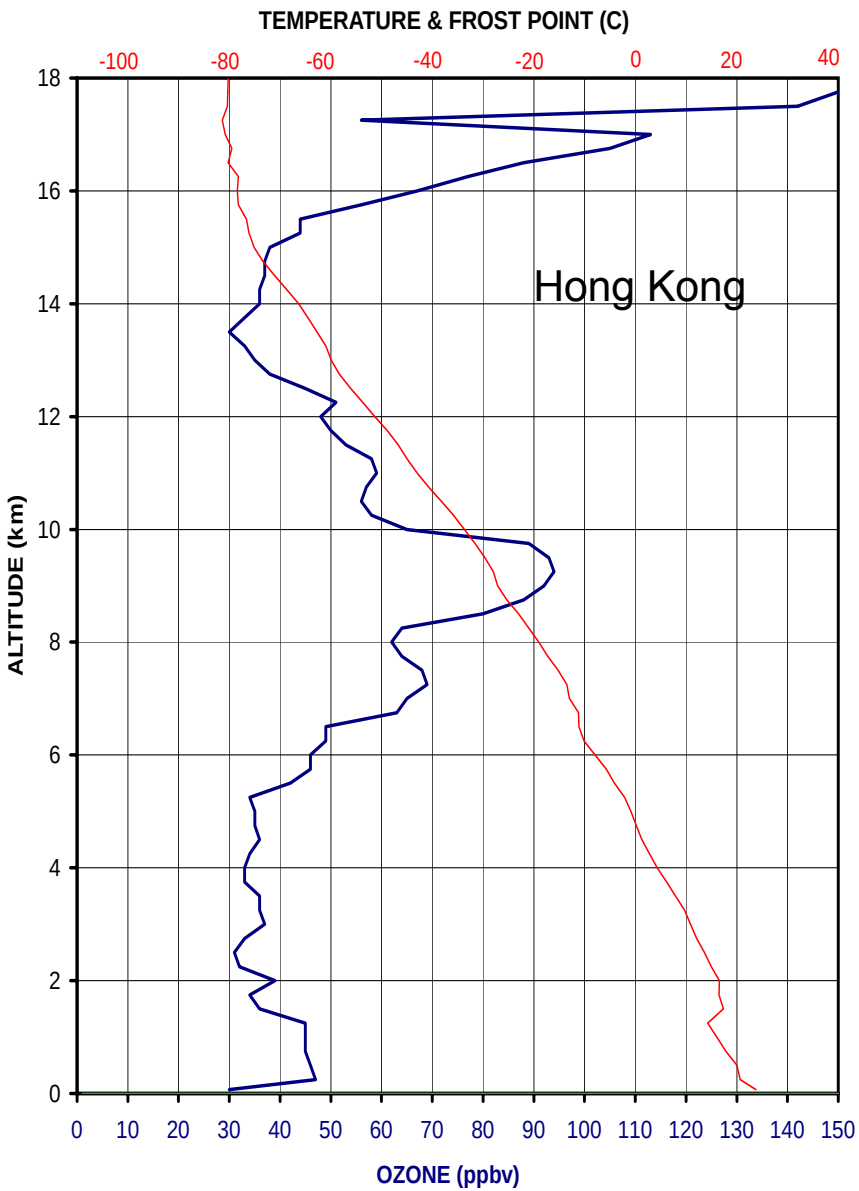
Station	Latitude	Longitude	Observations
Hilo, Hawaii	19.4°N	155.4°W	1991-present
Hong Kong, China	22.2°N	114.3°E	1993-present
Taipei, Taiwan	25.0°N	121.4°E	2000-2001
Naha, Japan	26.2°N	127.7°E	1990-present
Kagoshima, Japan	31.6°N	130.6°E	1990-present
Cheju Island, Korea	33.5°N	126.5°E	2001
Tateno, Japan	36.1°N	140.1°E	1990-present
Trinidad Head, Calif.	40.8°N	124.2°W	1997-present
Sapporo, Japan	43.1°N	141.3°E	1990-present

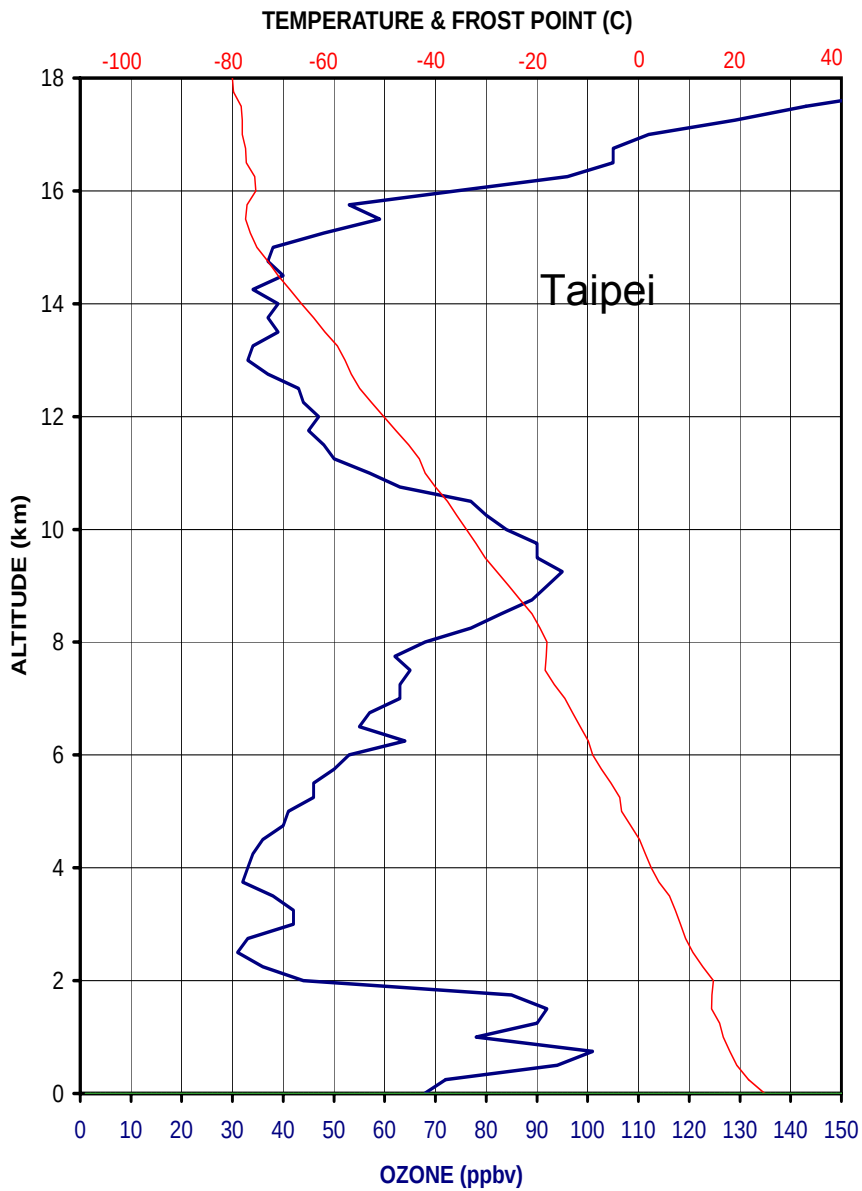
Average Ozone Mixing Ratio at Hong Kong (22N) and Taipei (25N) for February – April 2001





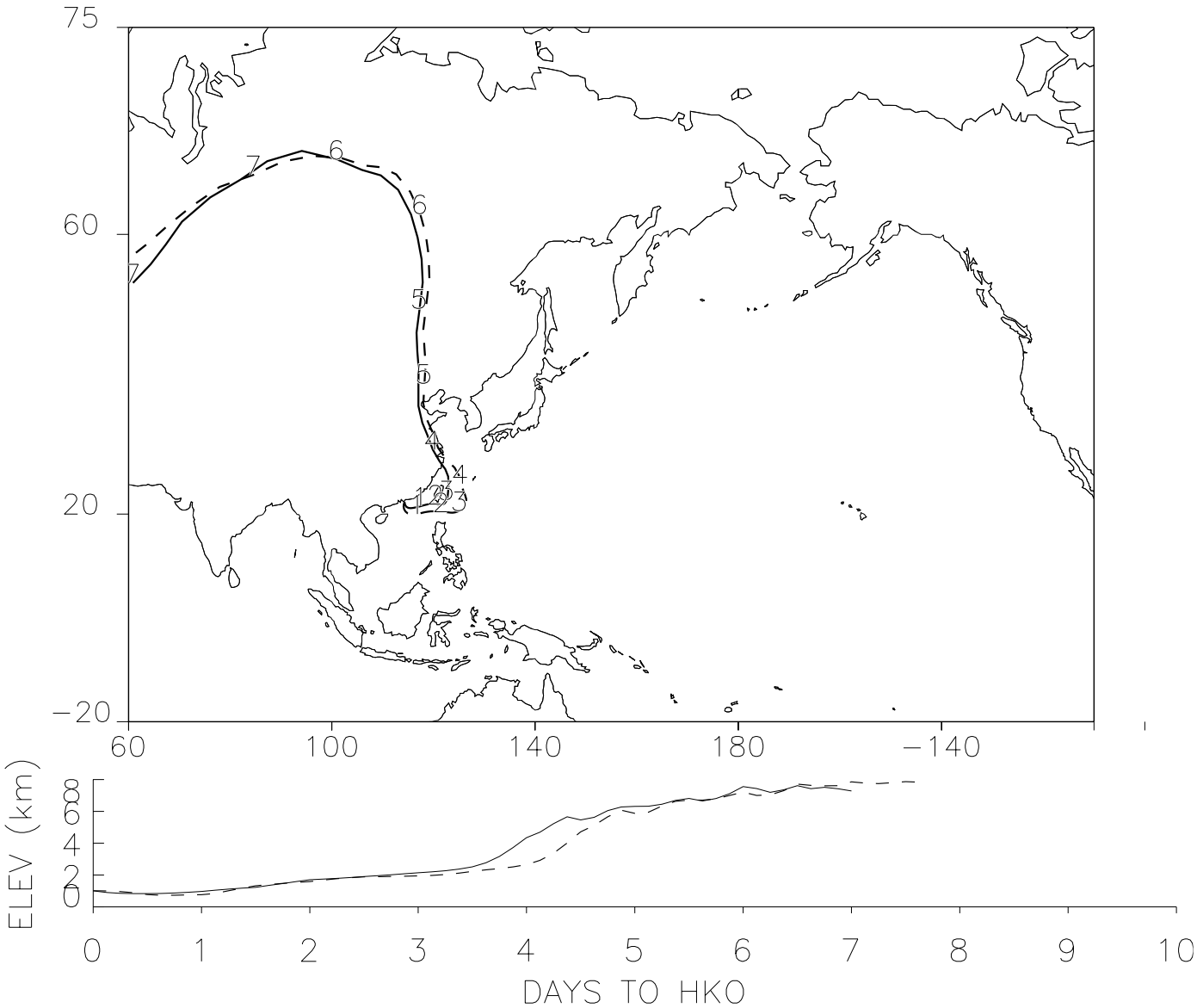
Ozone Mixing Ratio at Hong Kong (22N) on March 16, 2001 at 0539 GMT and Taipei (25N) on March 16, 2001 at 0700 GMT





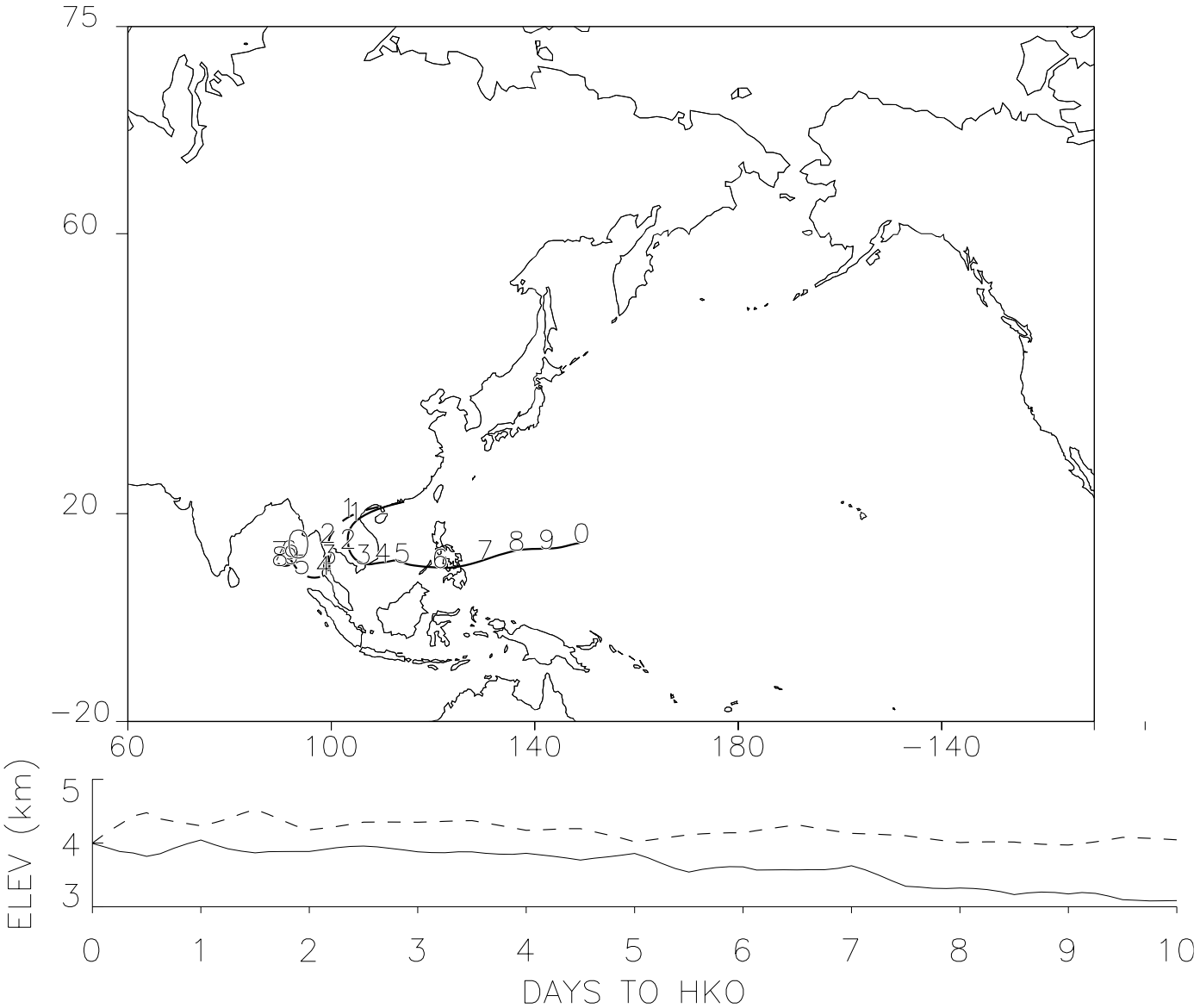
Back Trajectories to Hong Kong on March 16, 2001 at 00 and 12 GMT at 1 km

Solid Line = 00 GMT, Dashed Line = 12 GMT



Back Trajectories to Hong Kong on March 16, 2001 at 00 and 12 GMT at 4 km

Solid Line = 00 GMT Dashed Line = 12 GMT



Back Trajectories to Hong Kong on March 16, 2001 at 00 and 12 GMT at 9 km

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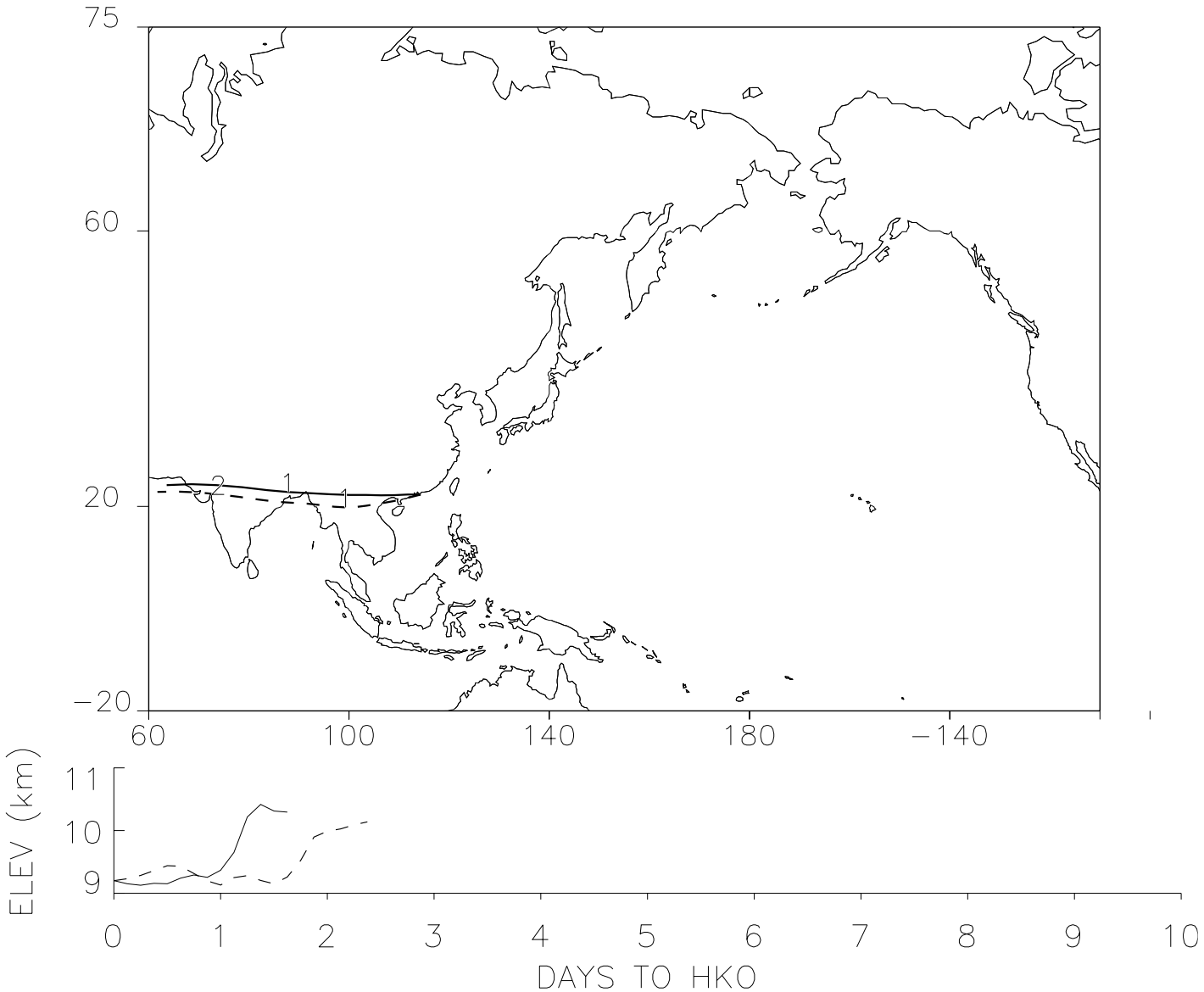

Back Trajectories to Hong Kong on March 16, 2001 at 00 and 12 GMT at 13 km

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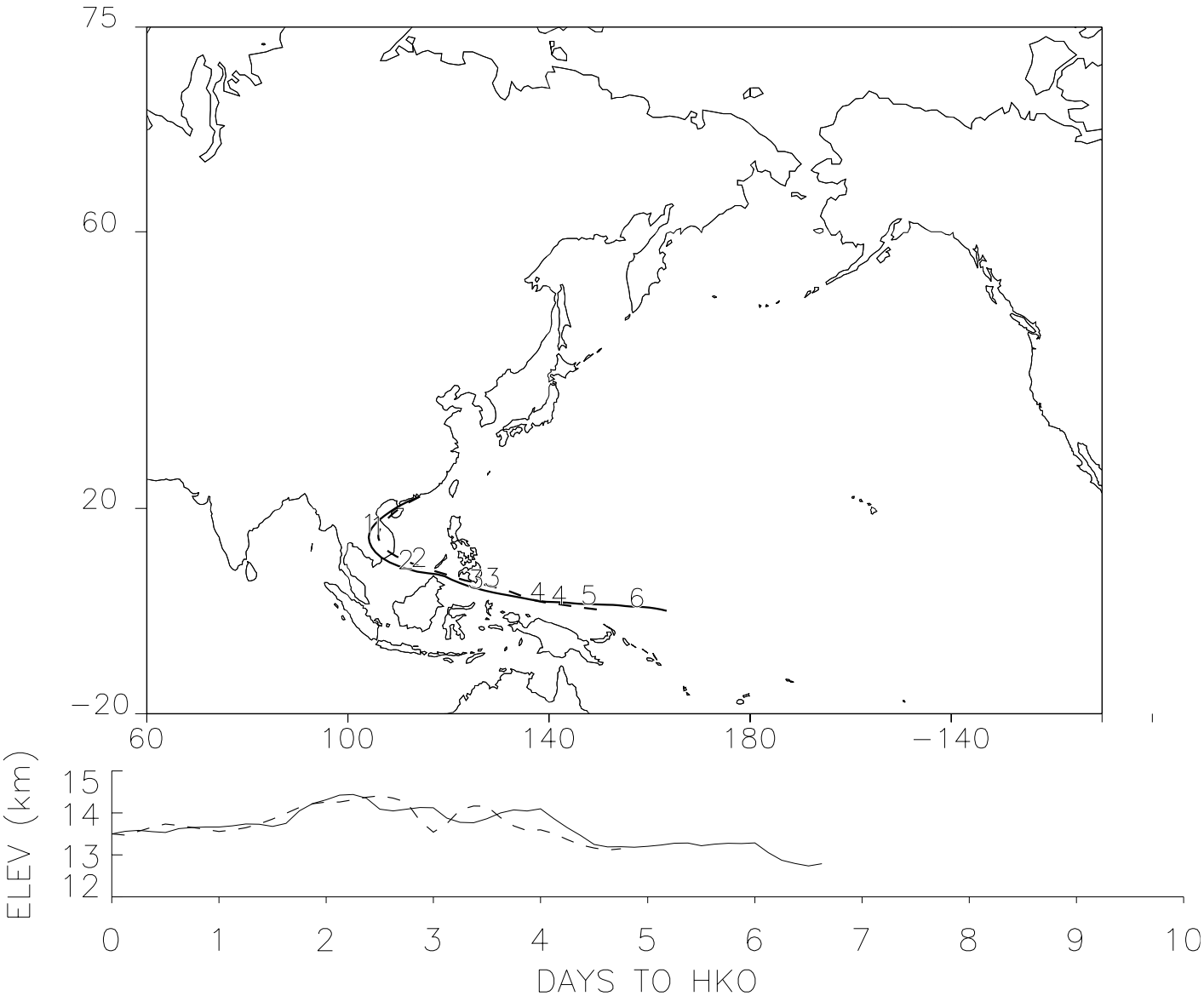
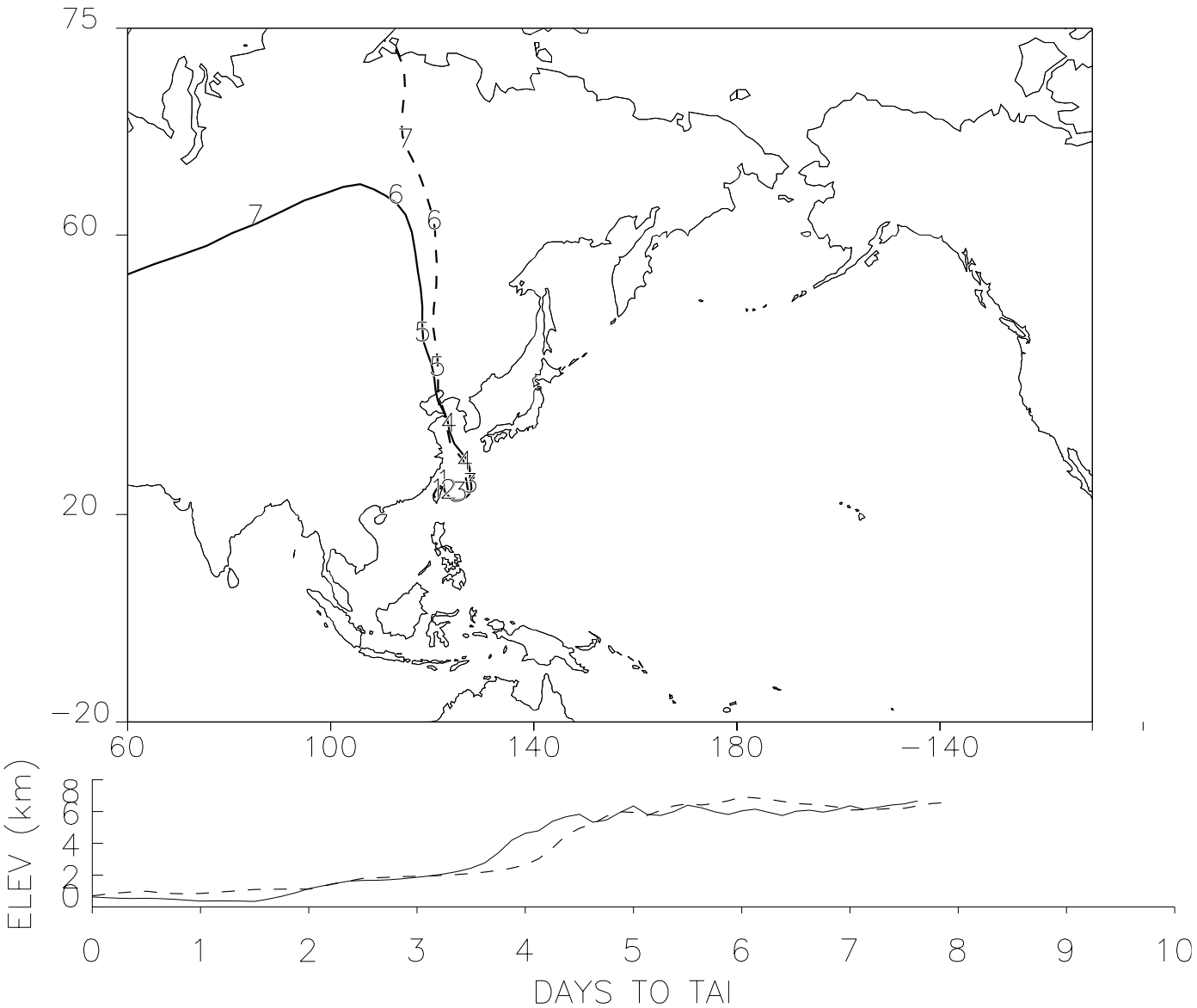


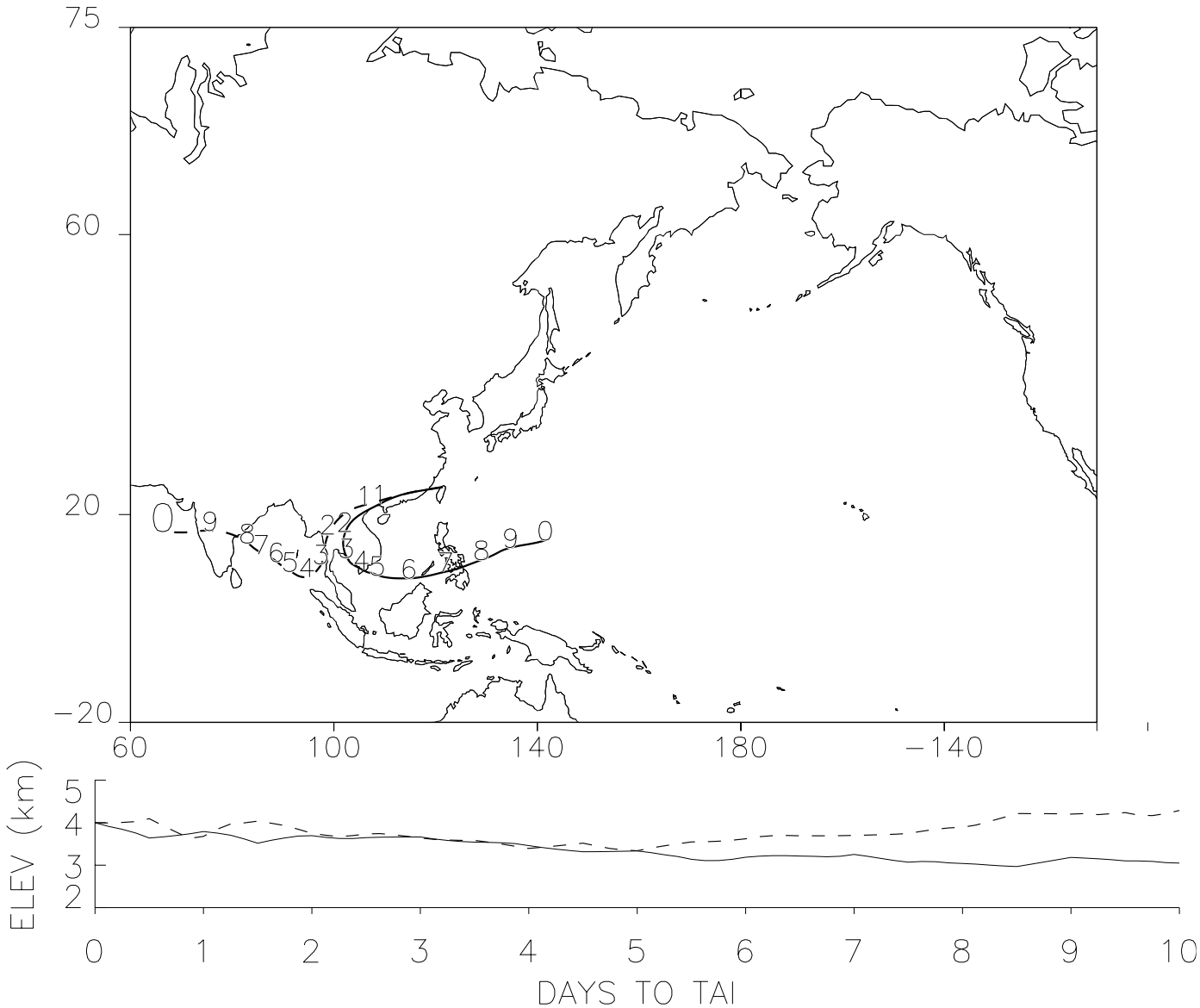
Back Trajectories to Taipei on March 16, 2001 at 00 and 12 GMT at 0.5 km

Solid Line = 00 GMT Dashed Line = 12 GMT



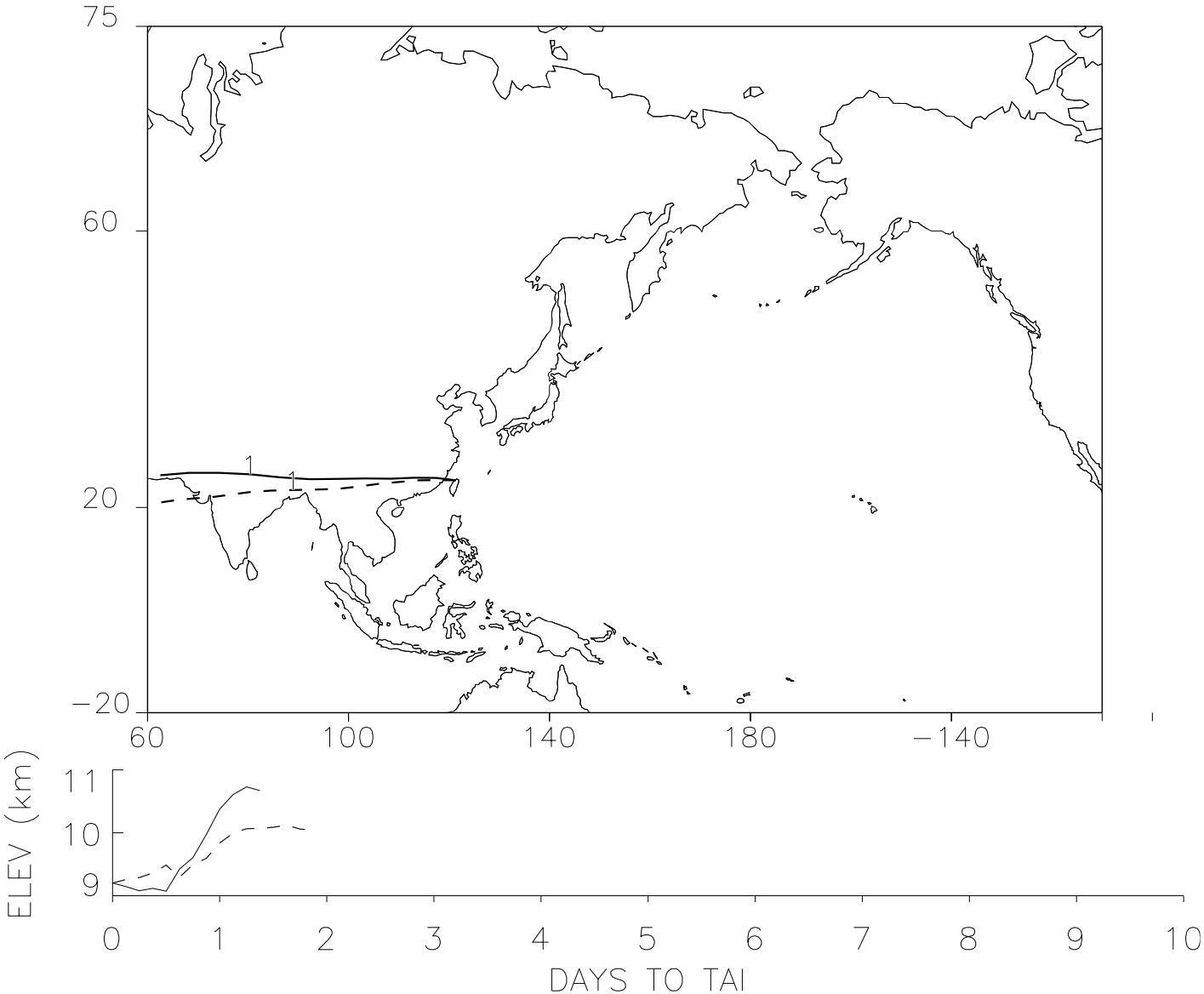
Back Trajectories to Taipei on March 16, 2001 at 00 and 12 GMT at 4 km

Solid Line = 00 GMT Dashed Line = 12 GMT



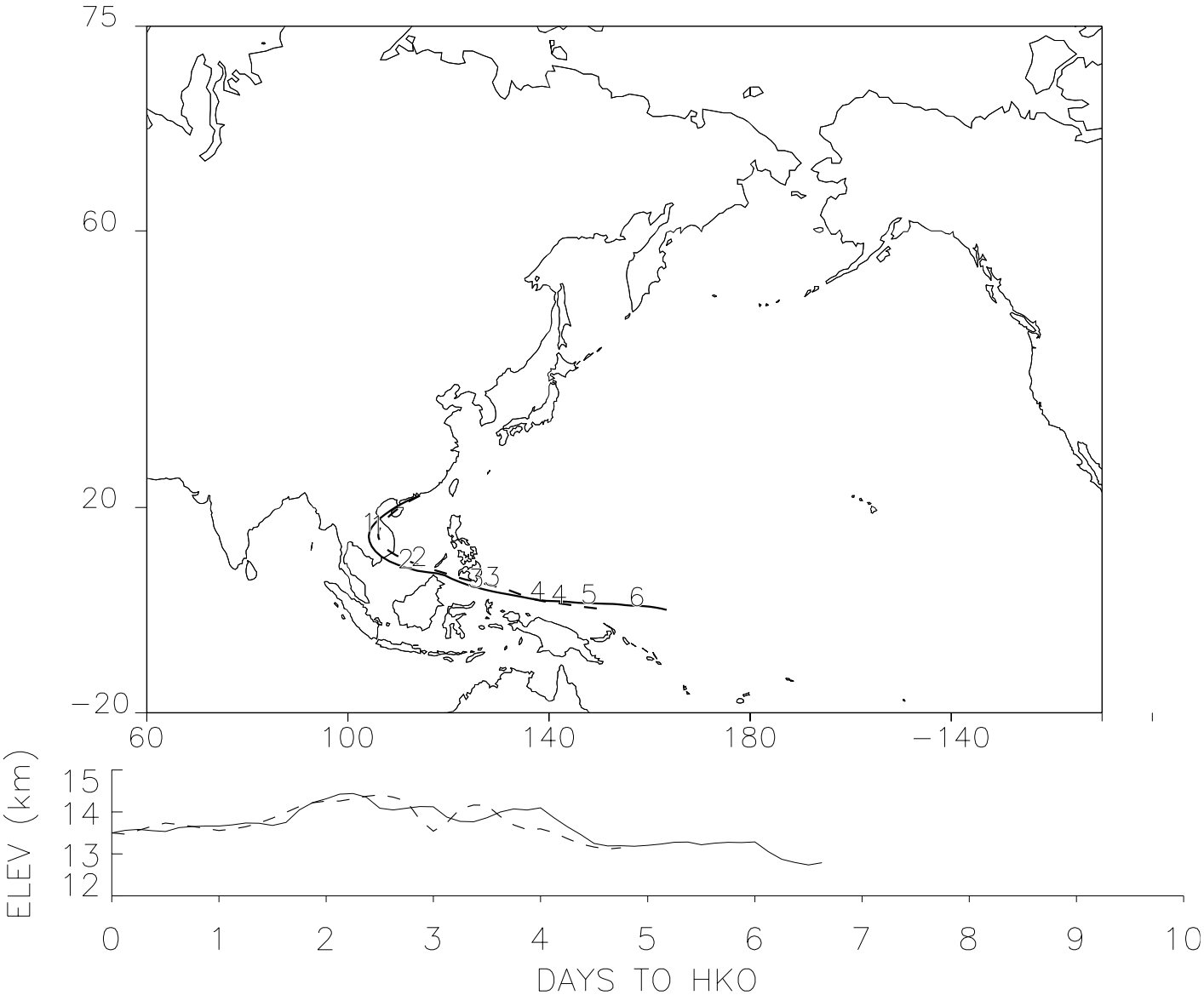
Back Trajectories to Taipei on March 16, 2001 at 00 and 12 GMT at 9 km

Solid Line = 00 GMT Dashed Line = 12 GMT

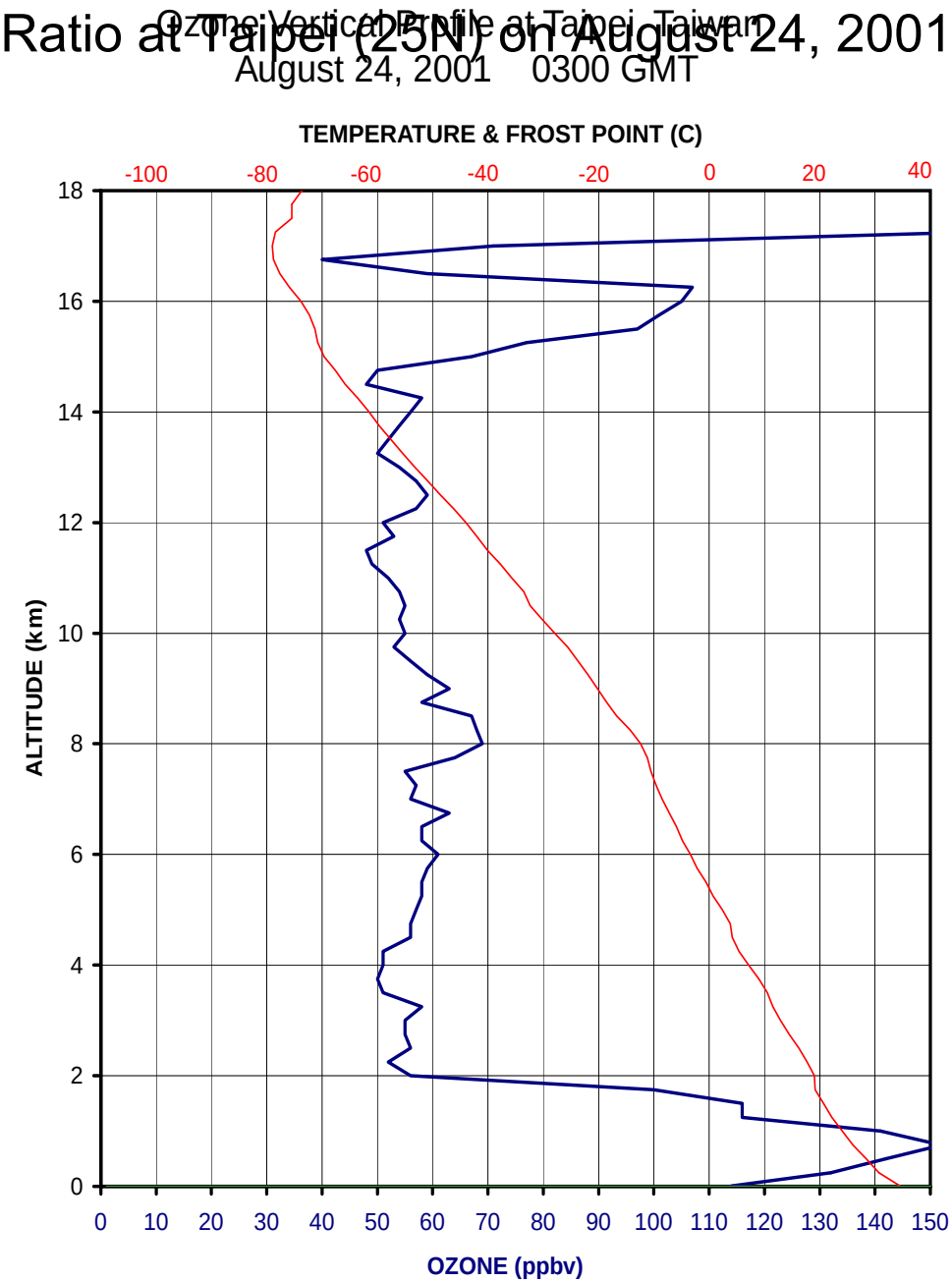


Back Trajectories to Taipei on March 16, 2001 at 00 and 12 GMT at 13 km

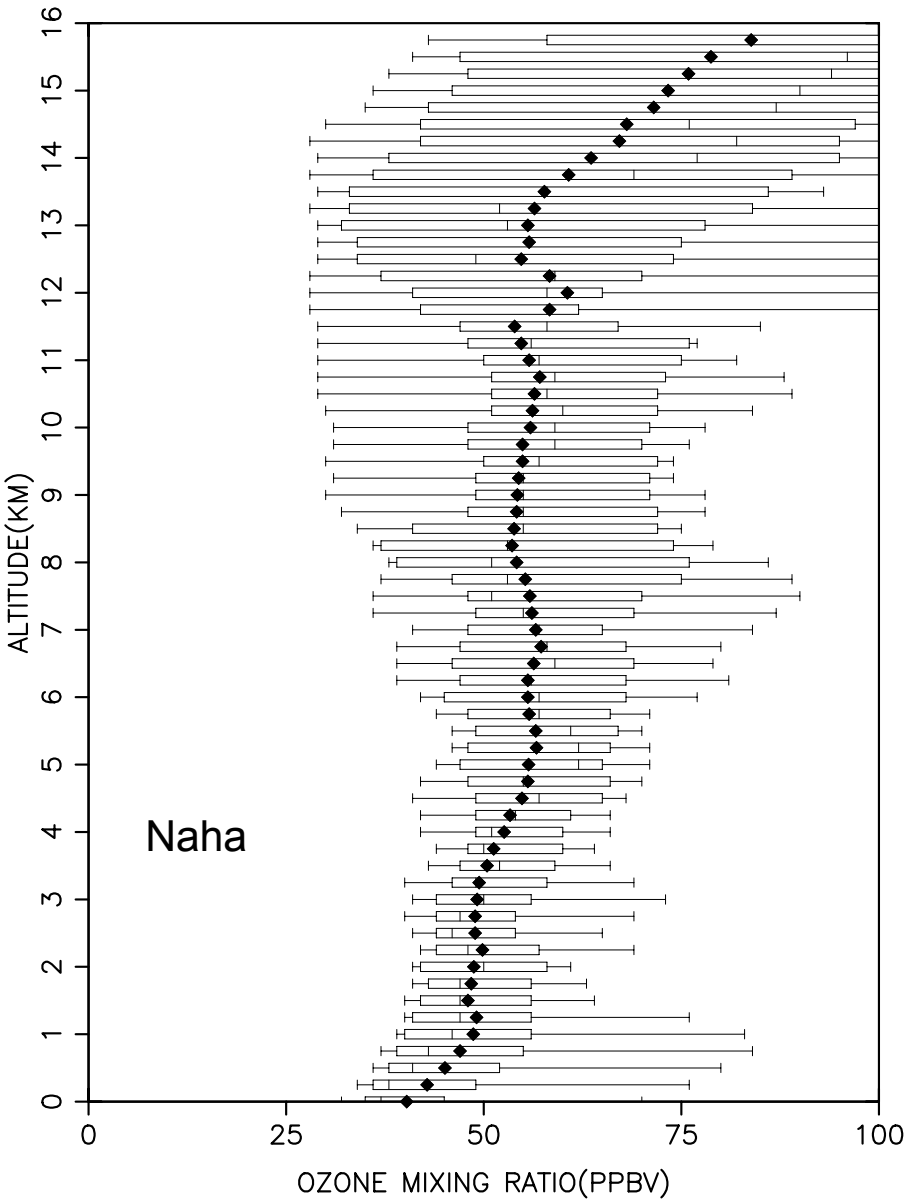
Solid Line = 00 GMT Dashed Line = 12 GMT

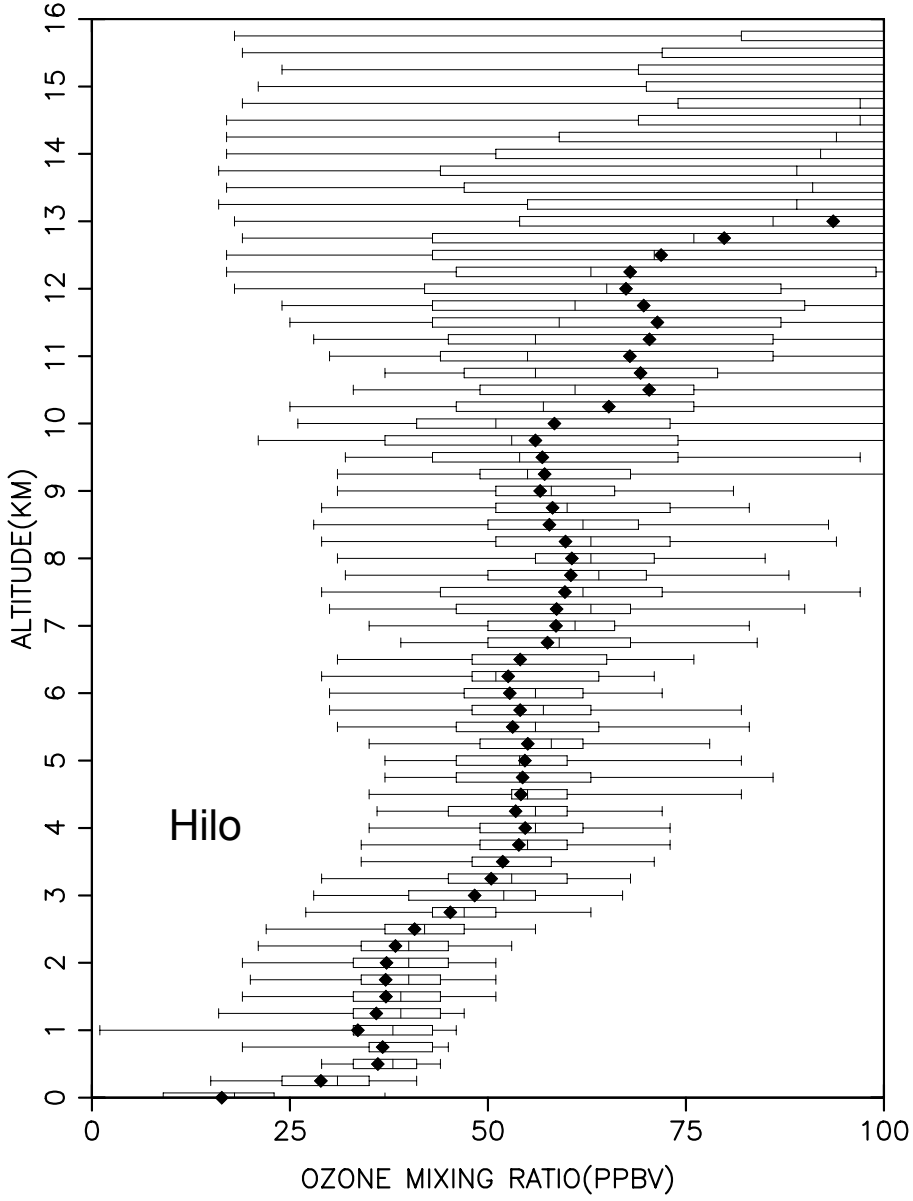


Ozone Mixing Ratio at Taipei (25N) on August 24, 2001 at 0300 GMT

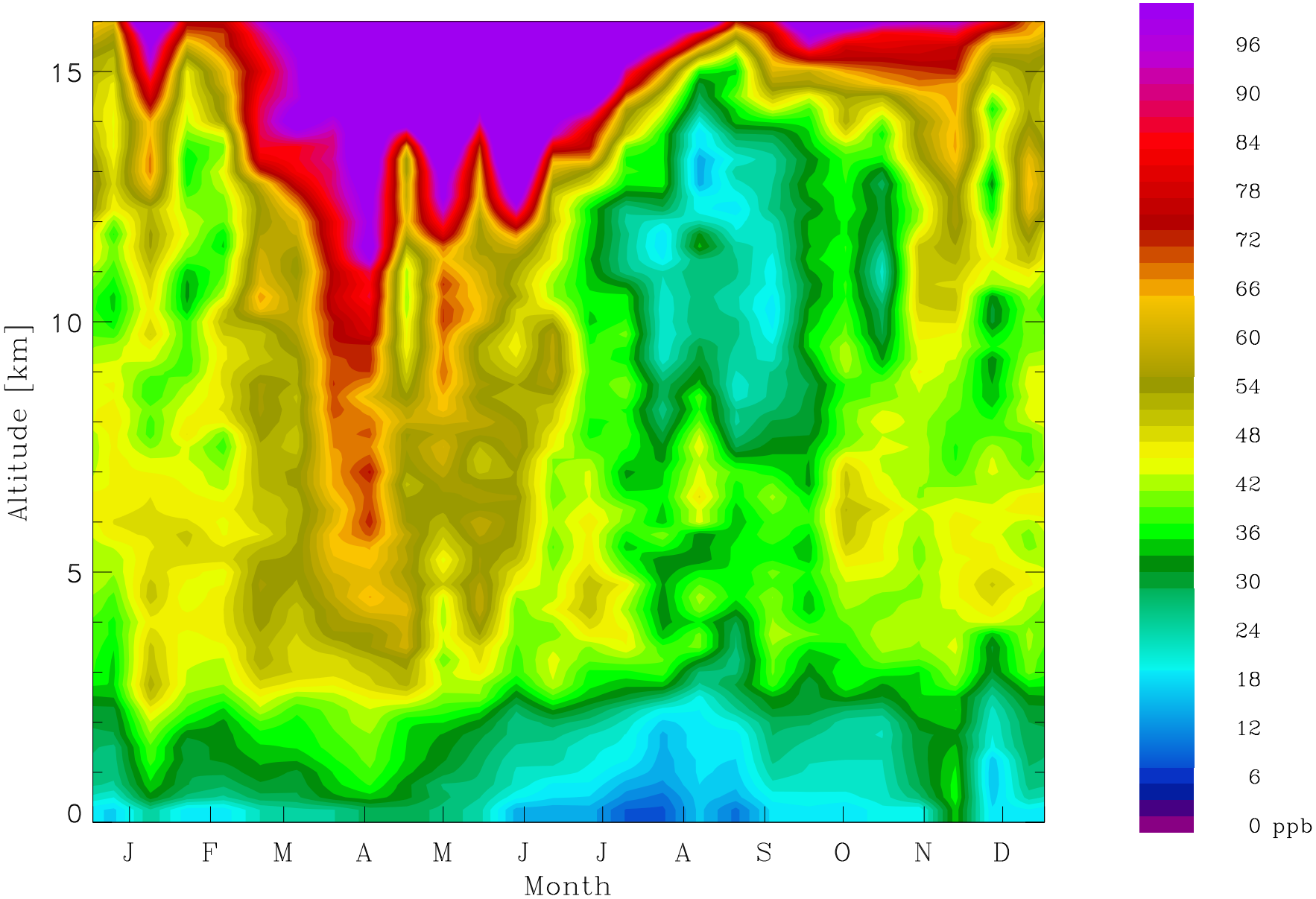


Average Ozone Mixing Ratio at Naha and Hilo for February – April 2001

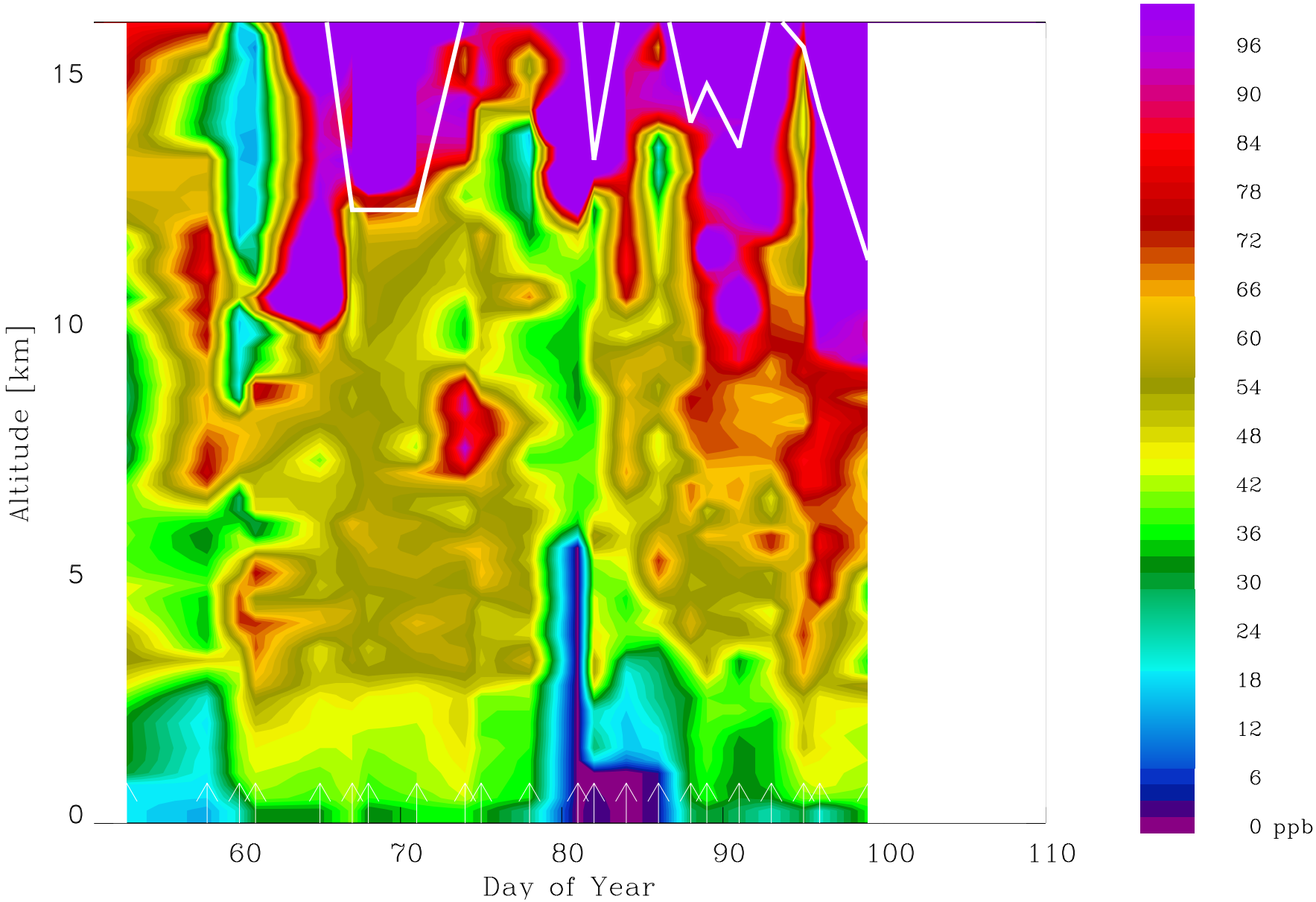




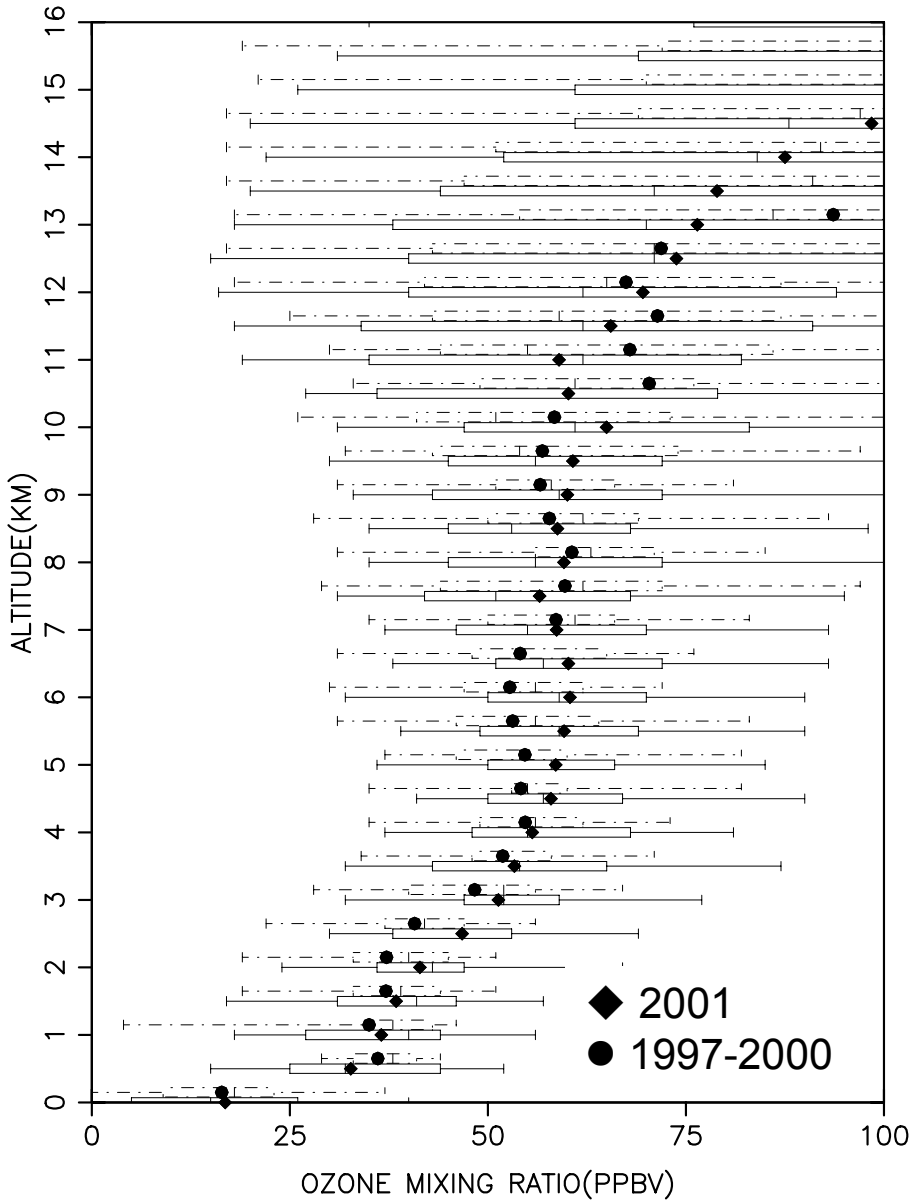
Hilo, Hawaii Average Ozone Mixing Ratio



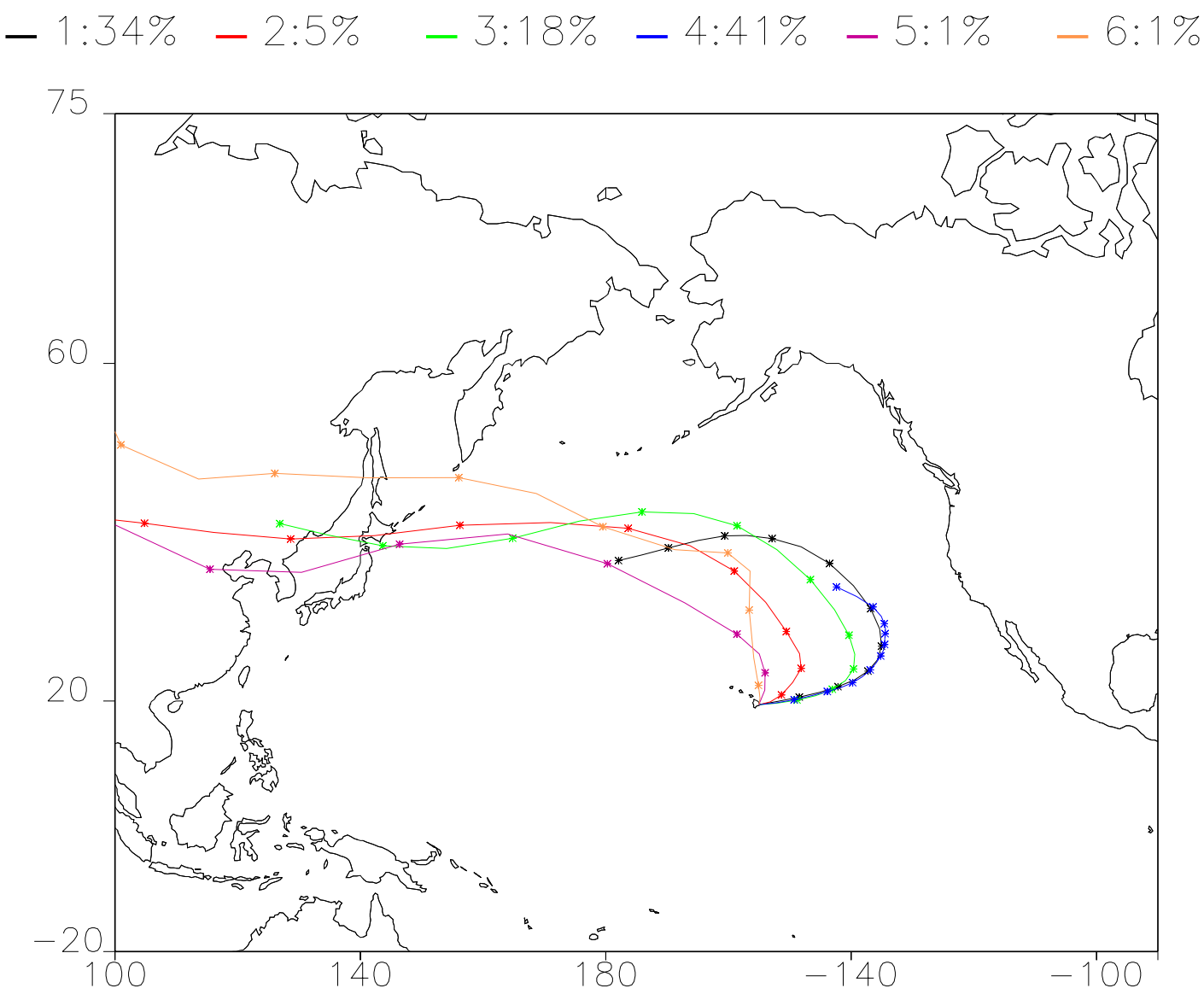
Hilo, Hawaii Ozone Mixing Ratio for February – April 2001



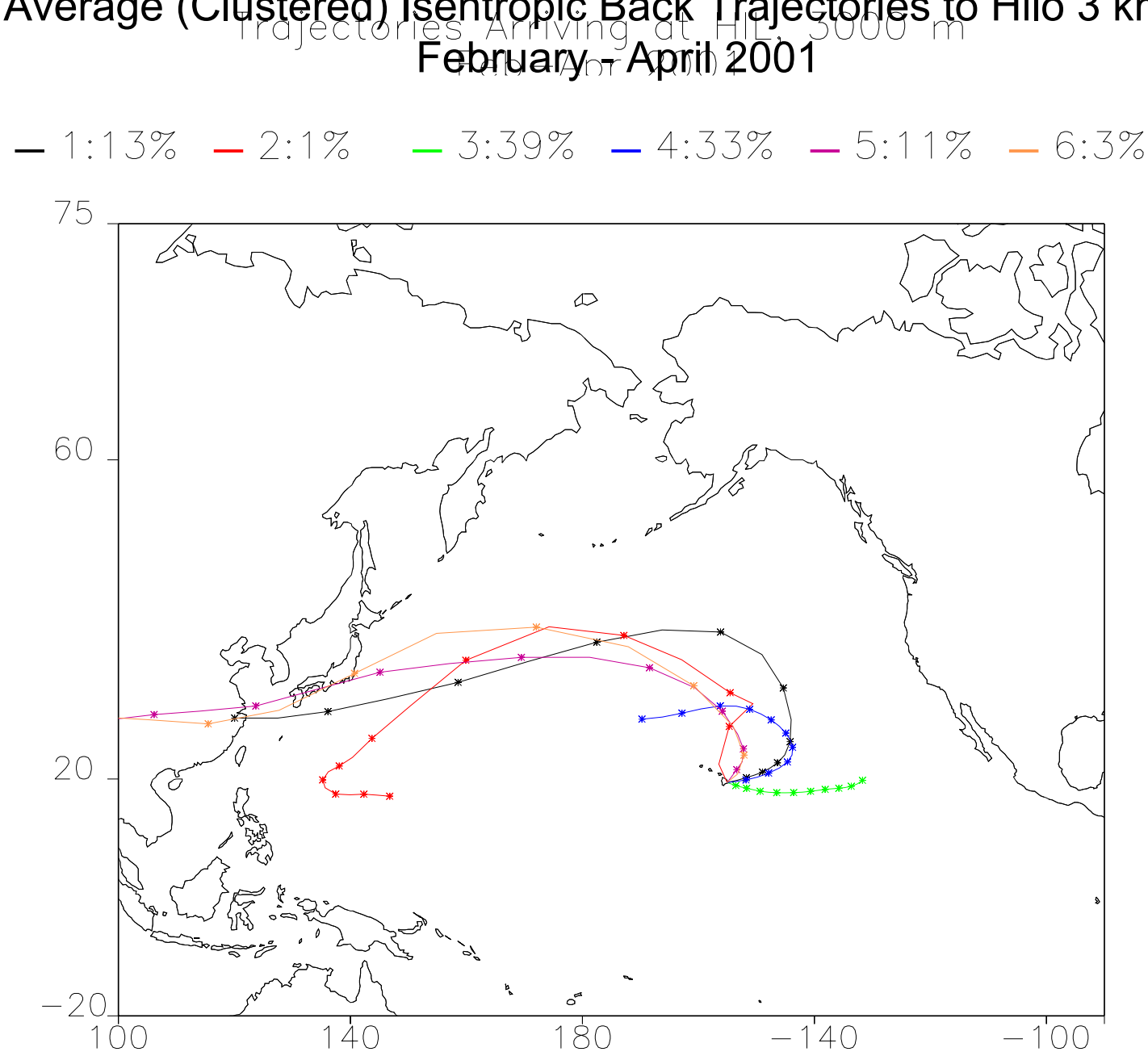
Hilo, Hawaii Average Ozone Mixing Ratio for February – April 2001 compared with February – April 1997-2000



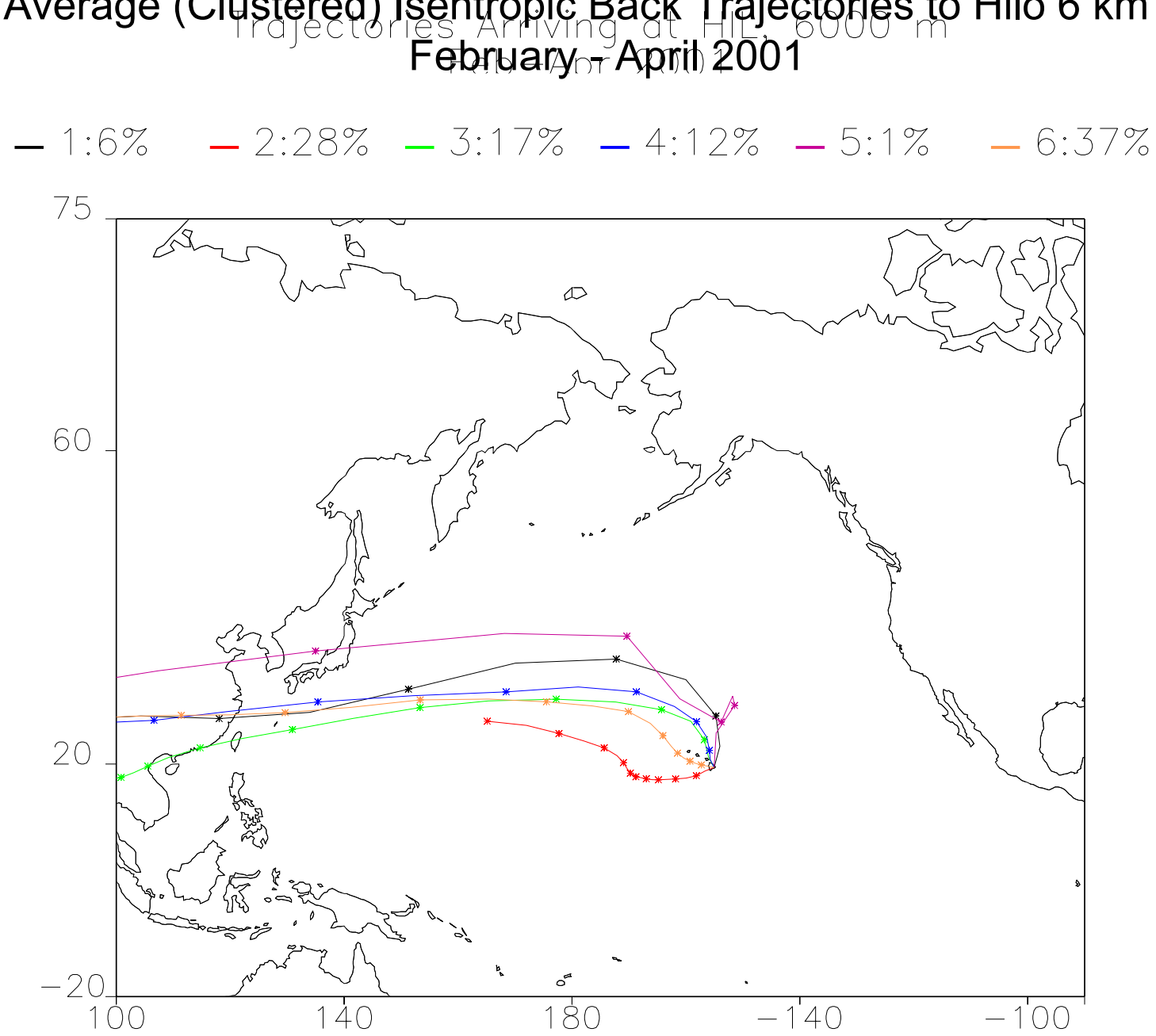
Average (Clustered) Isentropic Back Trajectories to Hilo 0.5 km for February - April 2001



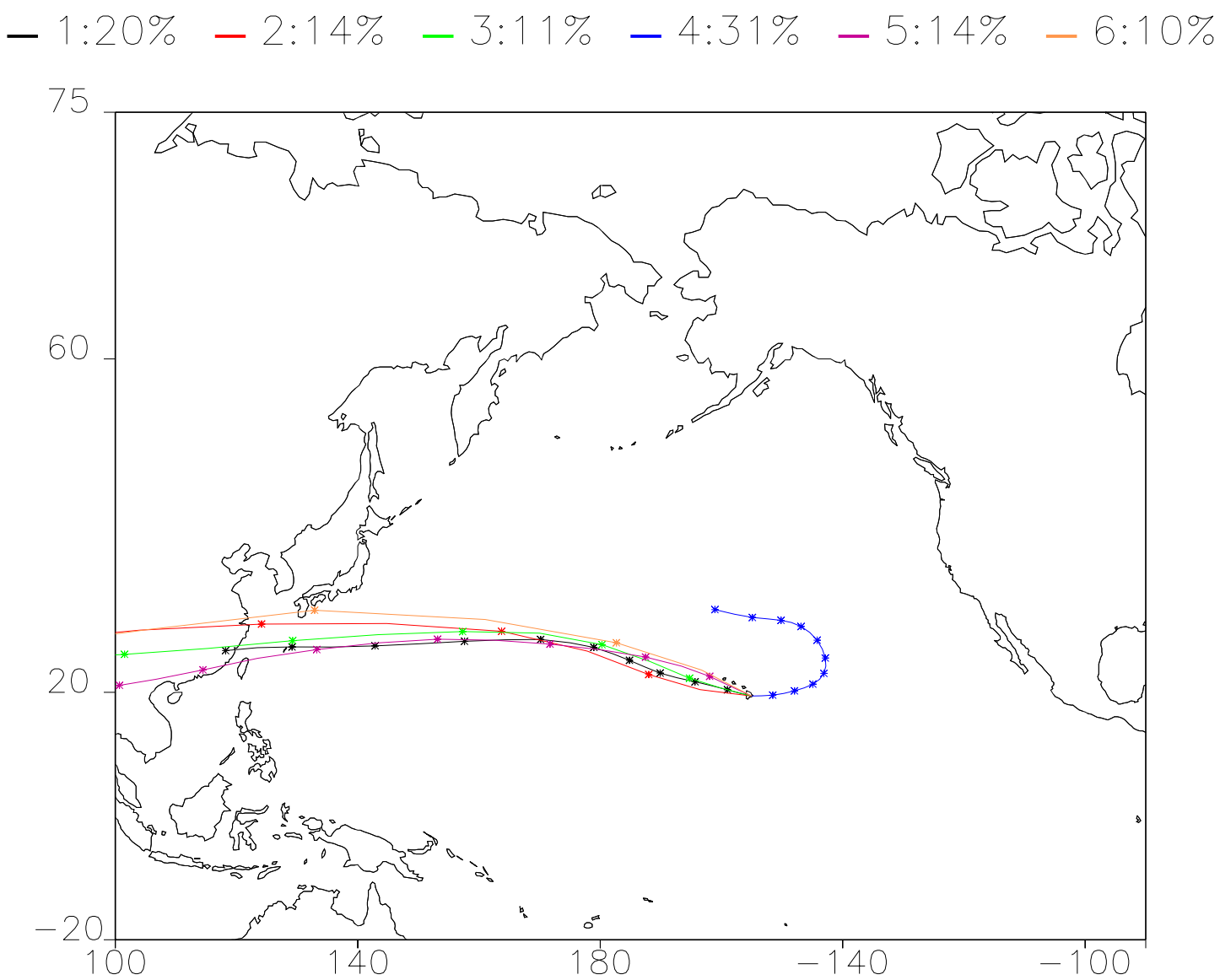
Average (Clustered) Isentropic Back Trajectories to Hilo 3 km for February - April 2001



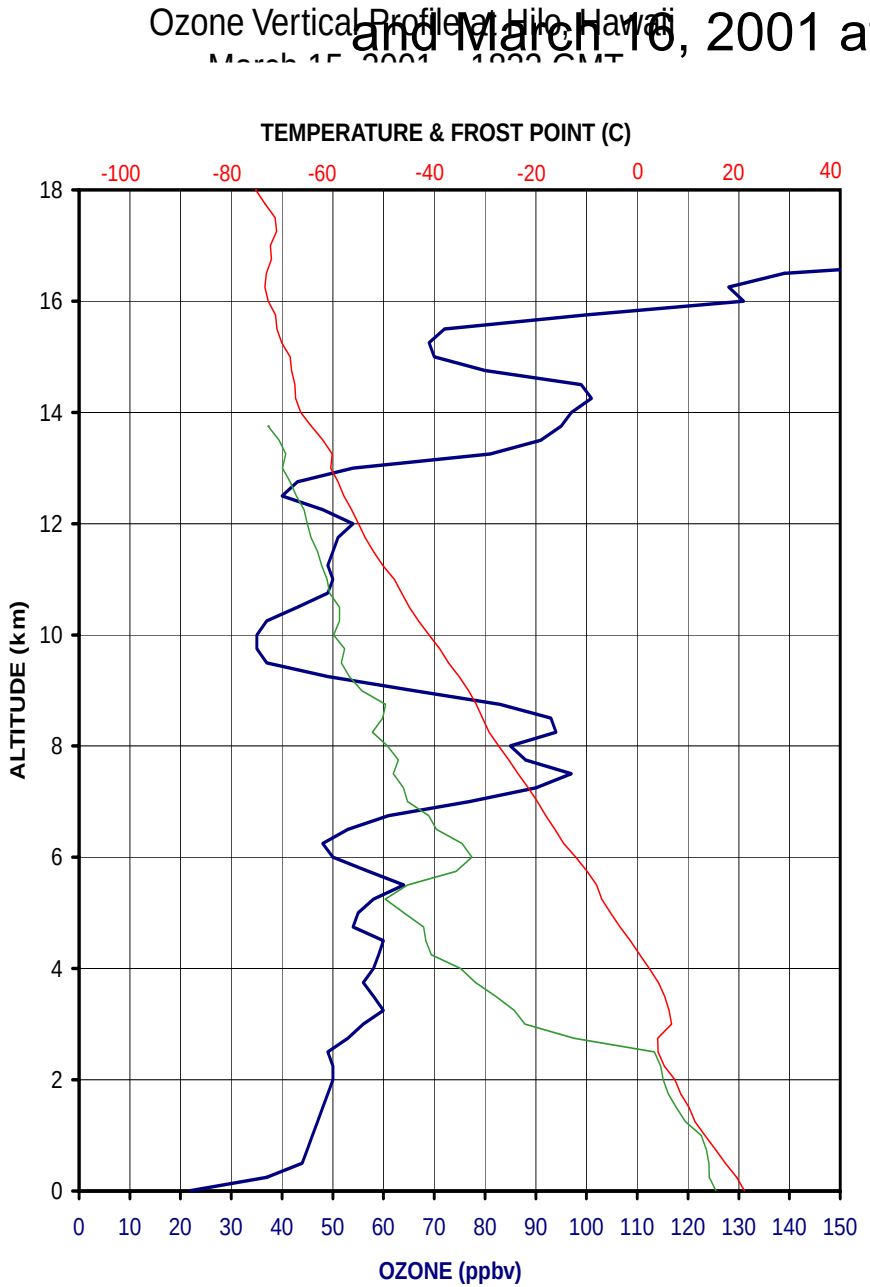
Average (Clustered) Isentropic Back Trajectories to Hilo 6 km for February - April 2001

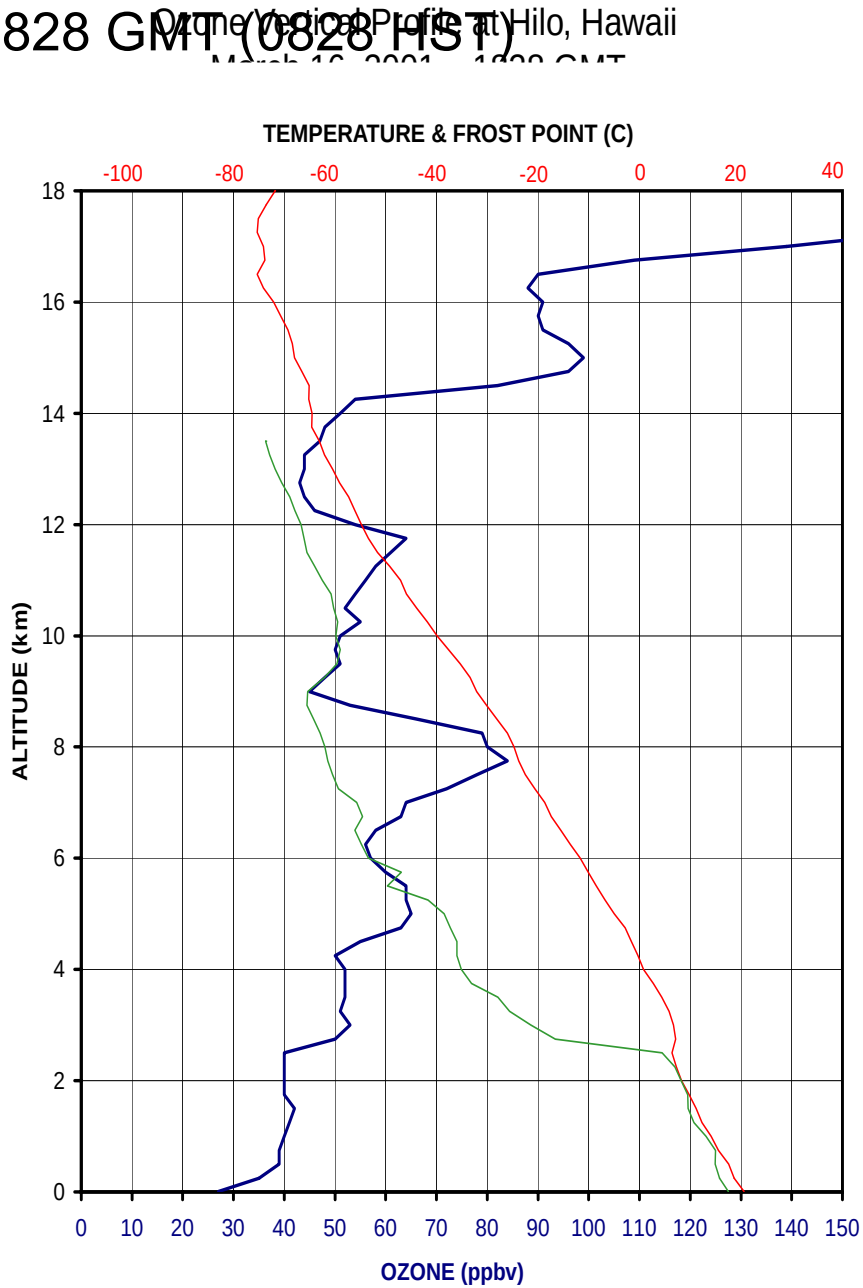


Average (Clustered) Isentropic Back Trajectories to Hilo 9 km for February - April 2001

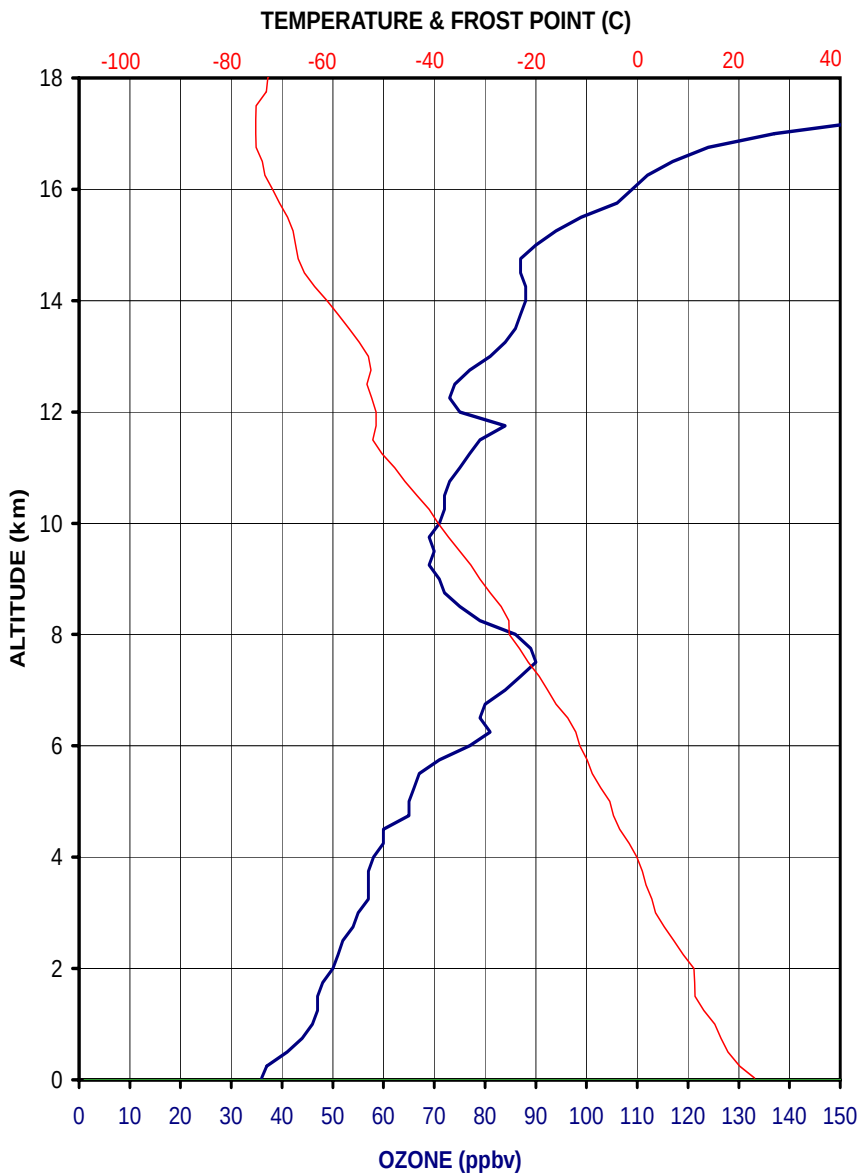


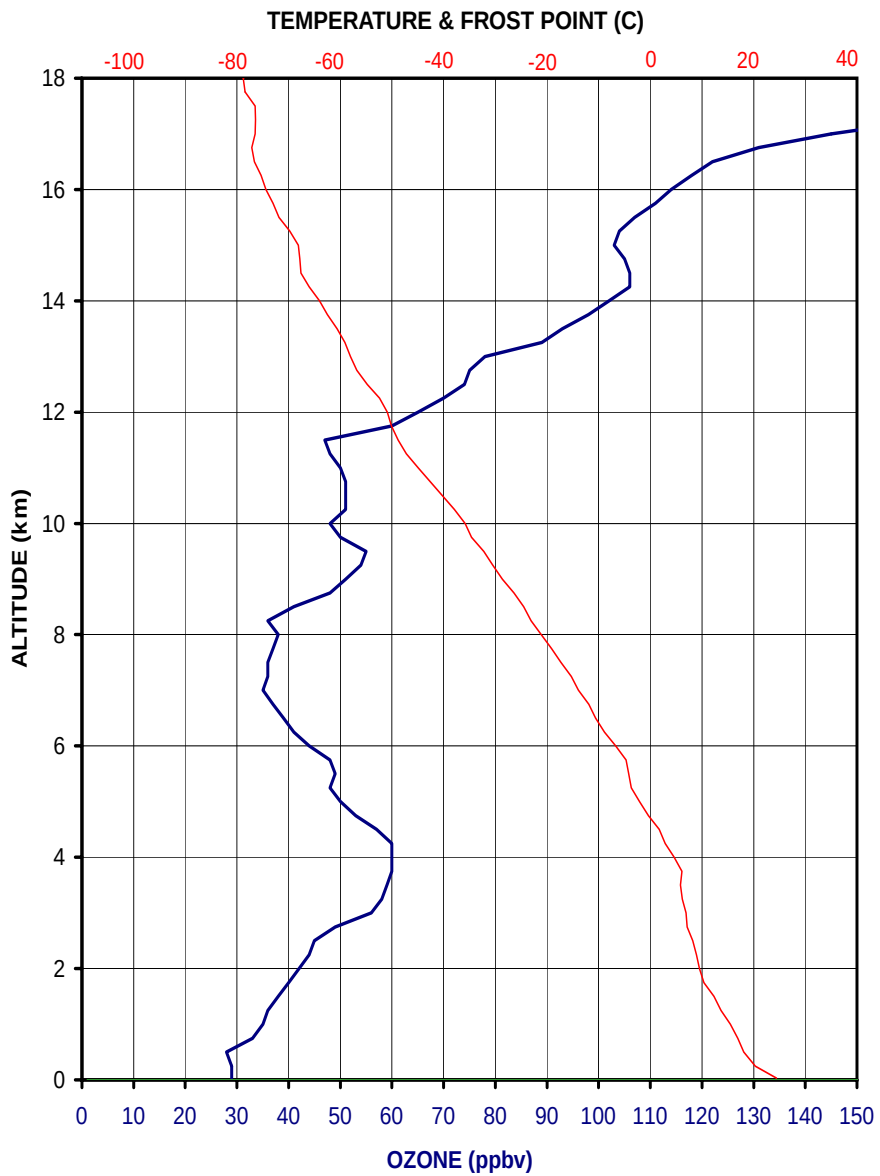
Ozone Mixing Ratio at Hilo, HI (19.4N) on March 15, 2001 at 1832 GMT and March 16, 2001 at 1828 GMT (0828 HST)



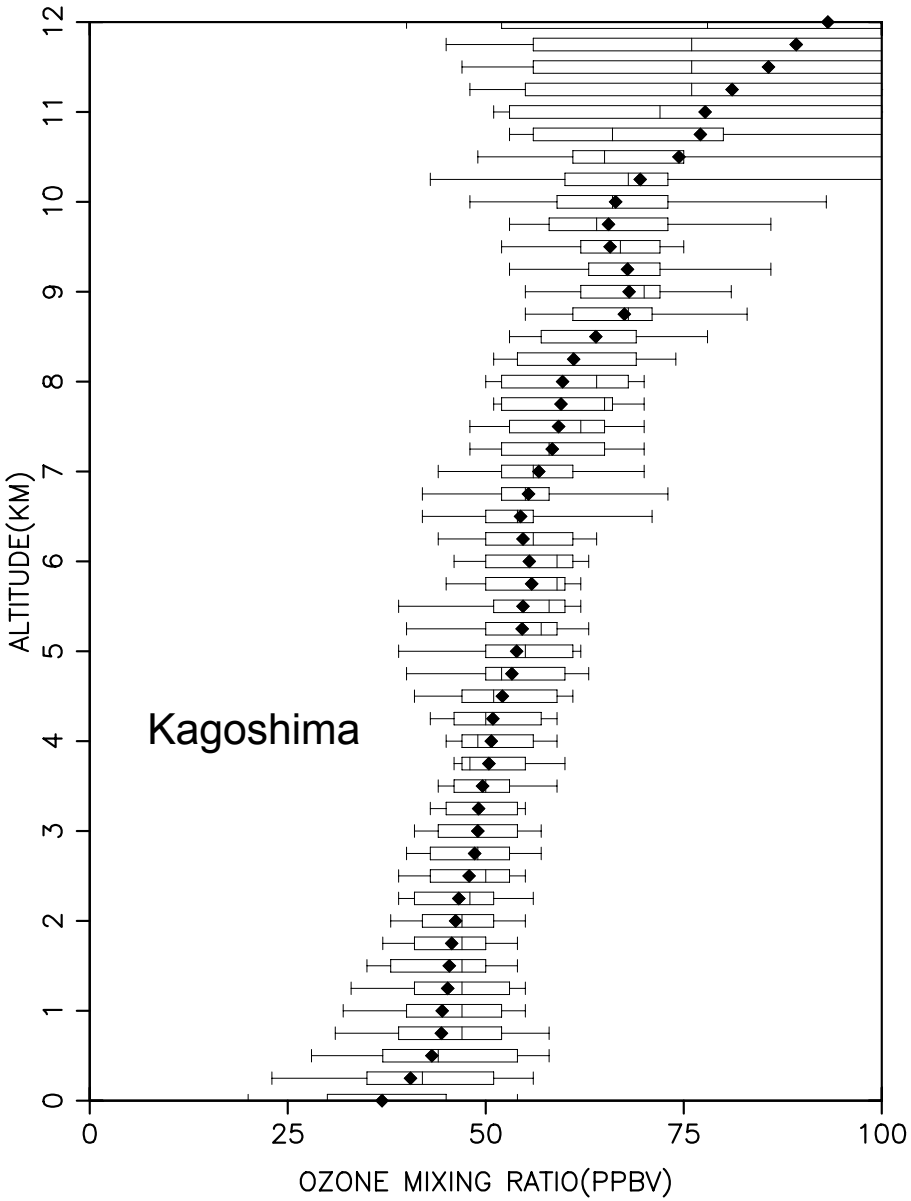


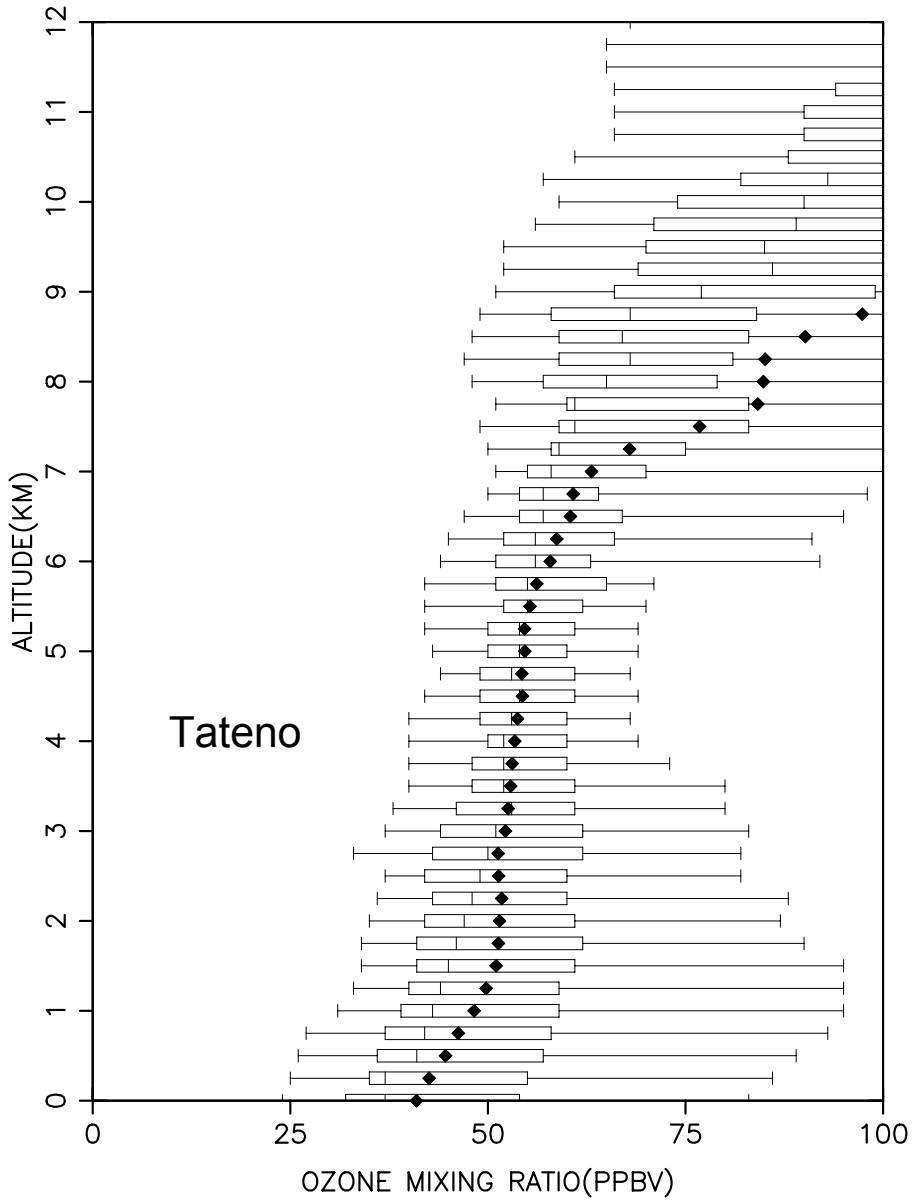
Ozone Mixing Ratio at Naha, Japan (26.2N) on April 6, 2001 at 0530 GMT and April 11, 2001 at 0530 GMT



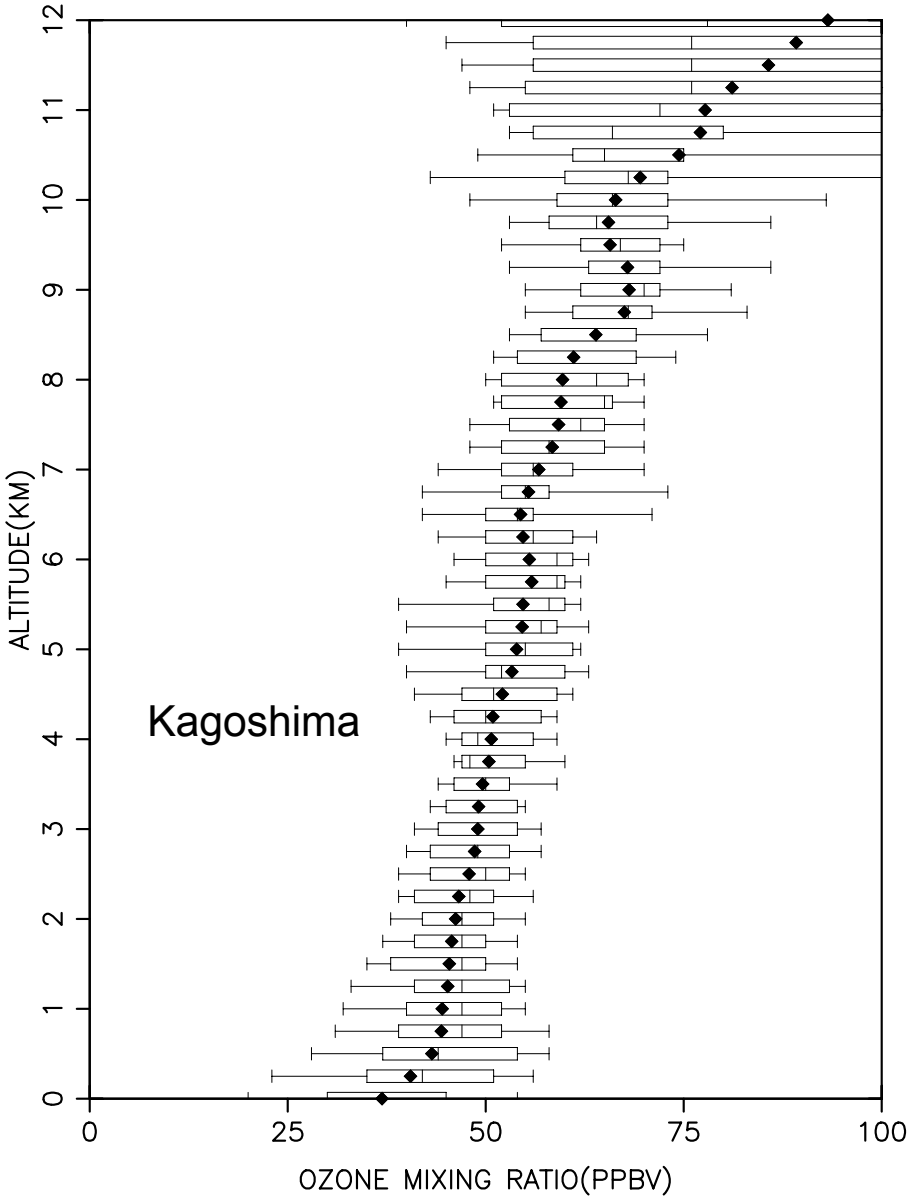


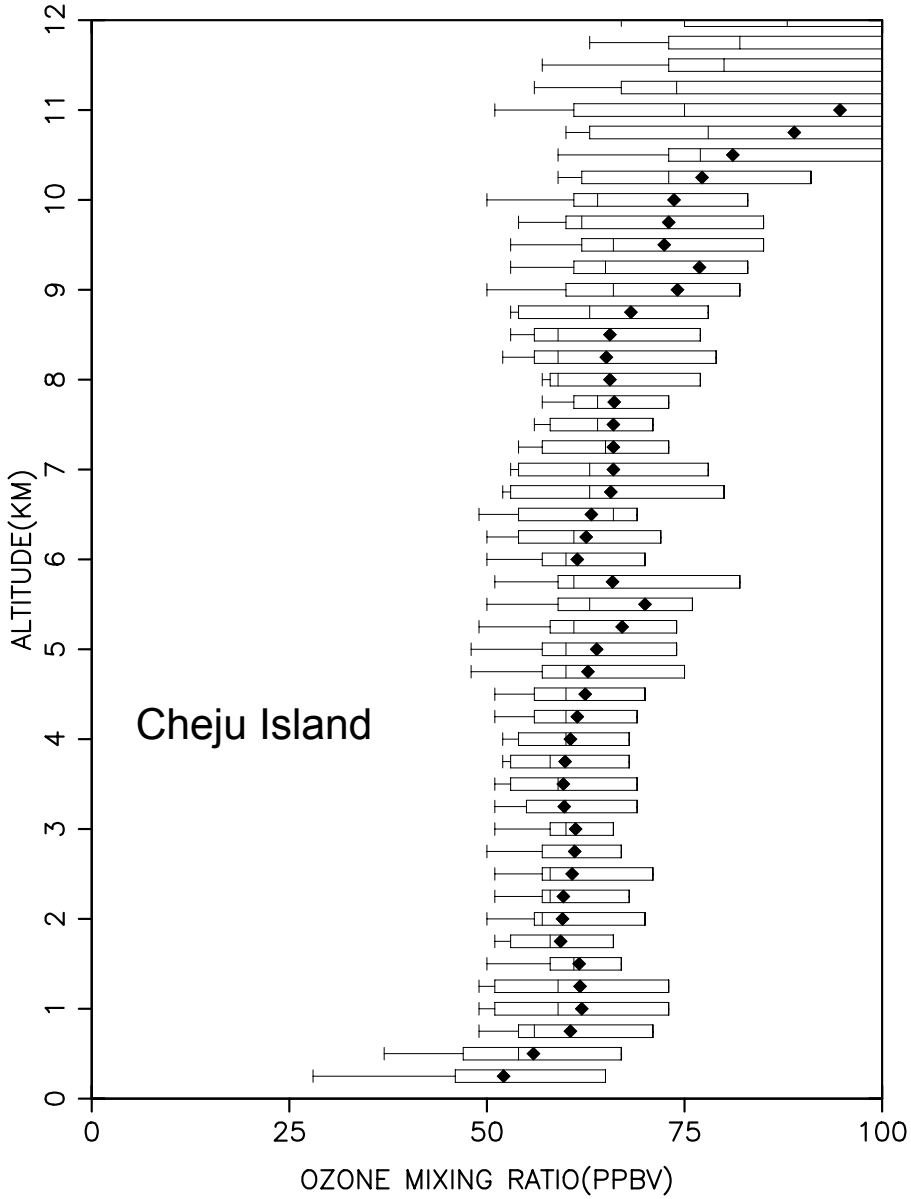
Average Ozone Mixing Ratio at Kagoshima (32N) and Tateno (36N) for February – April 2001



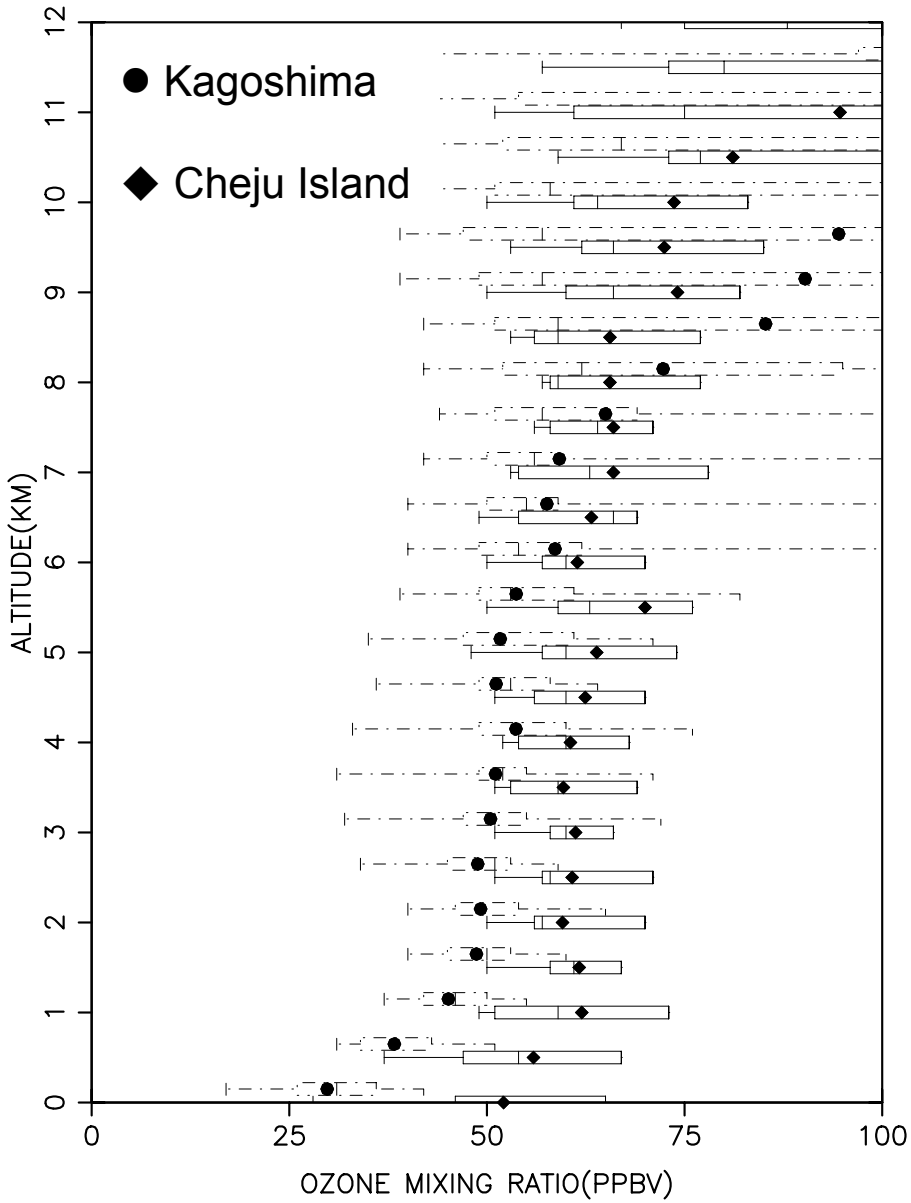


Average Ozone Mixing Ratio at Kagoshima (32N) and Cheju Isl. (33N) for February – April 2001

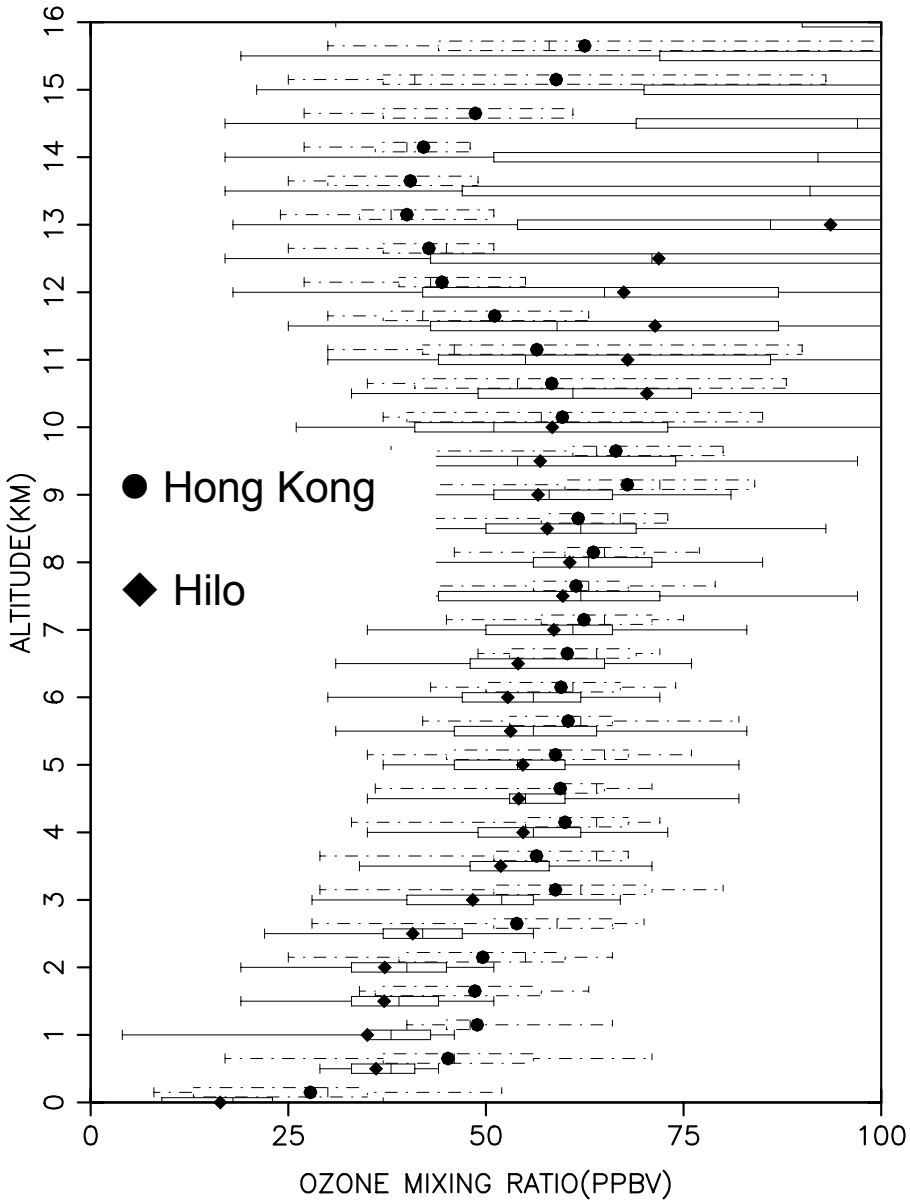




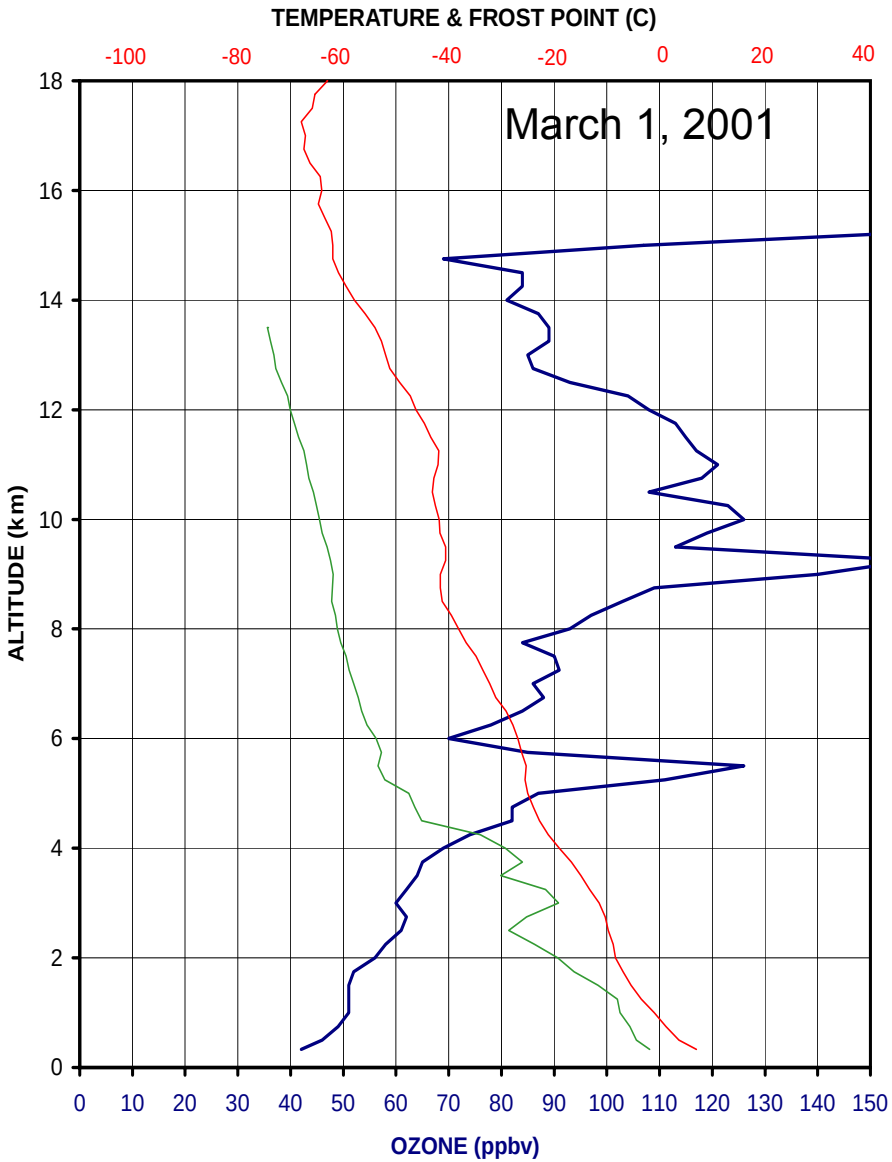
Average Ozone Mixing Ratio at Kagoshima (32N) and Cheju Isl. (33N) for February – April 2001

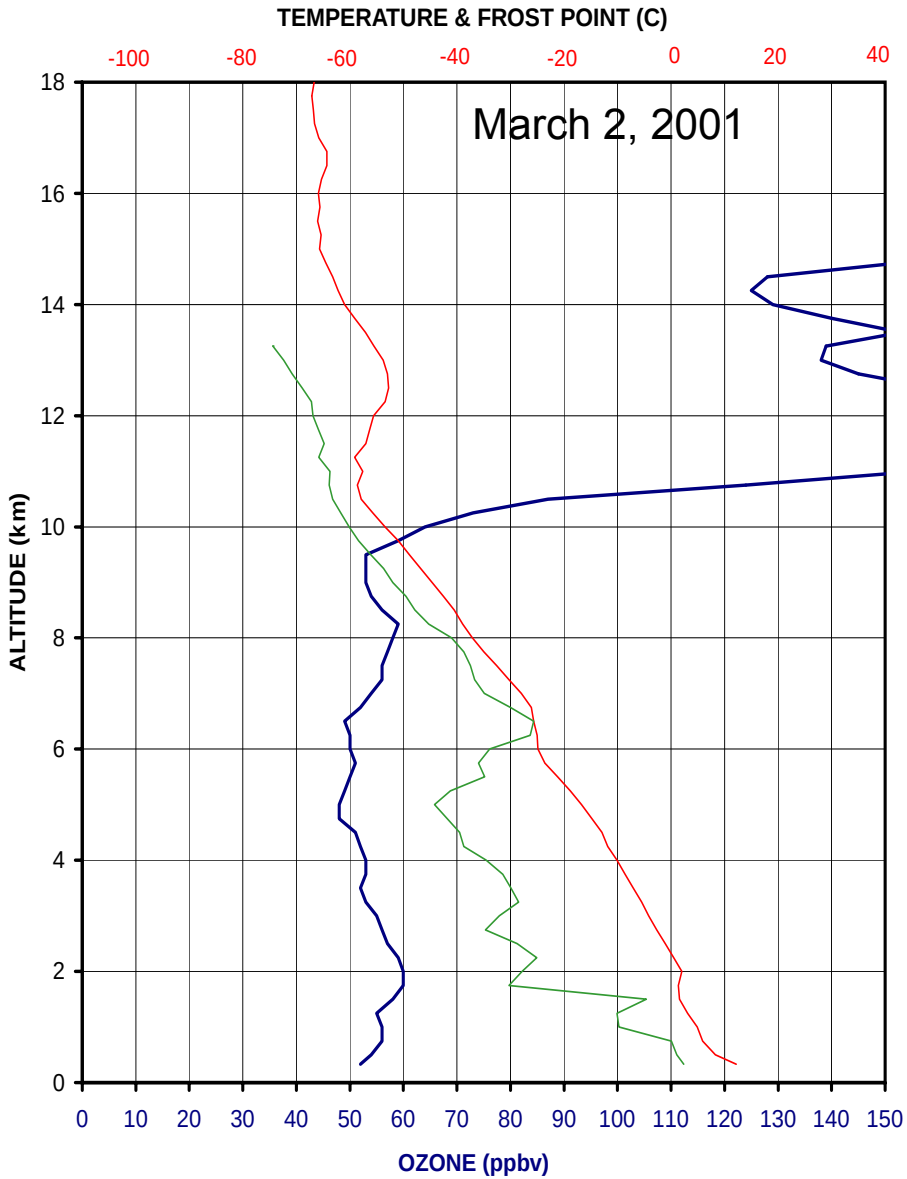


Average Ozone Mixing Ratio at Hilo (19N) and Hong Kong (22N) for February – April 2001

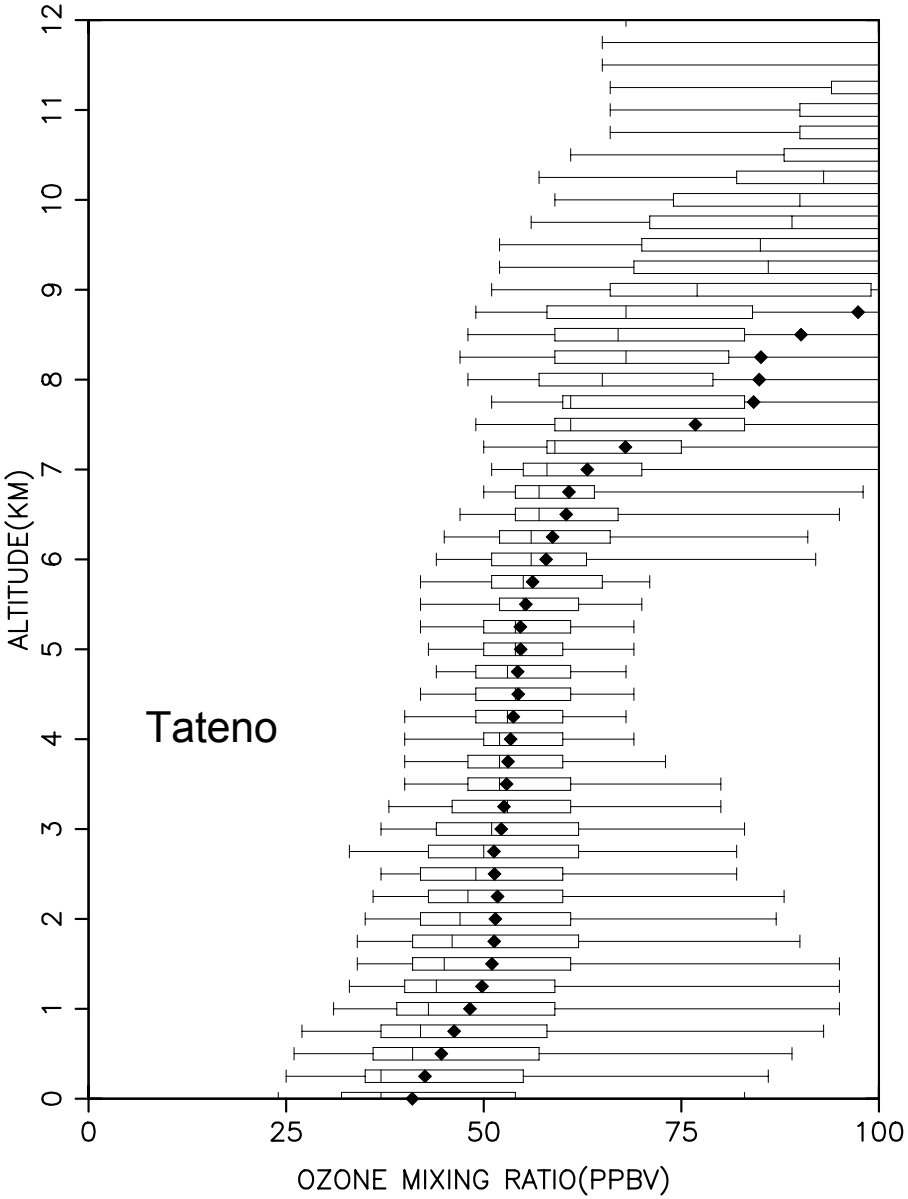


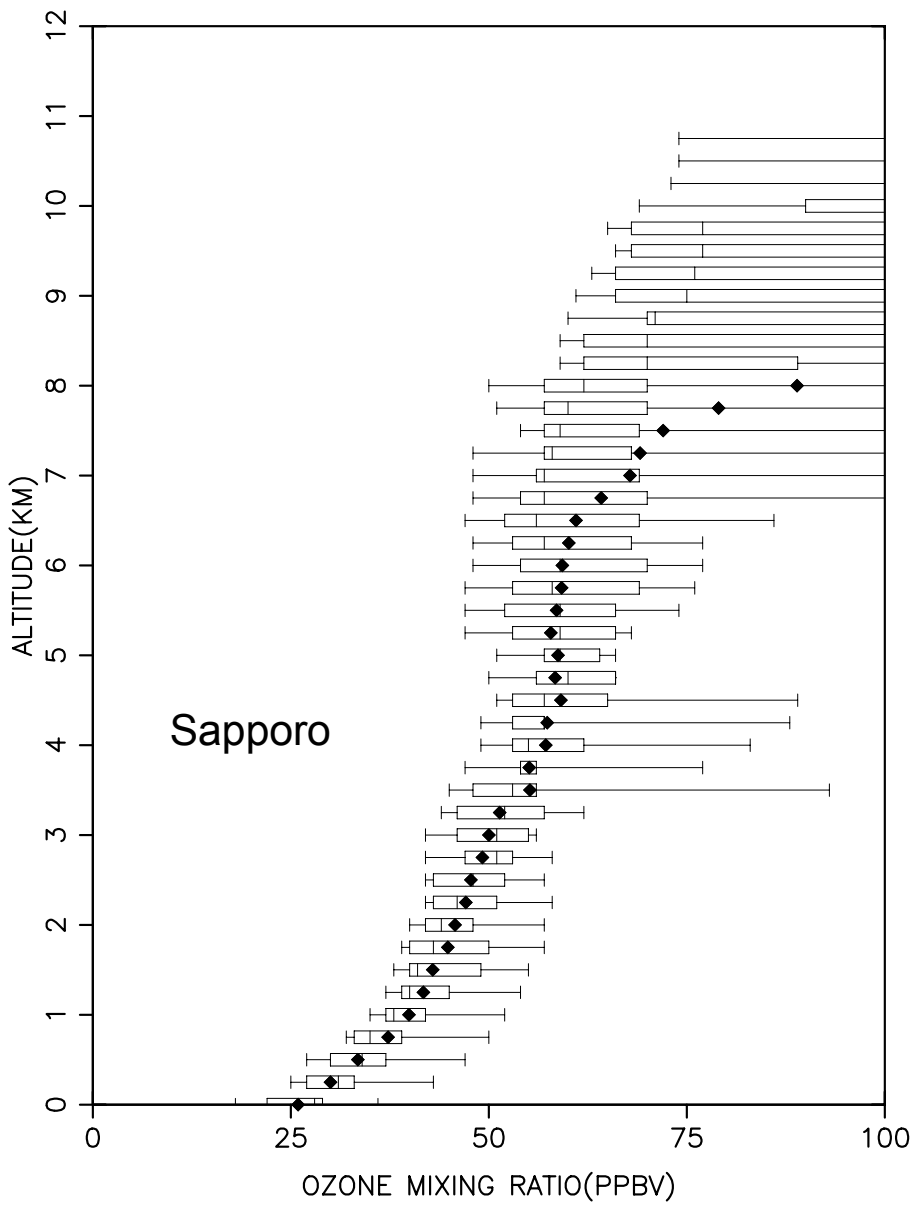
Ozone Mixing Ratio at Cheju Island, Korea (33.5N) on March 1, 2001 at 0413 GMT and March 2, 2001 at 0617 GMT



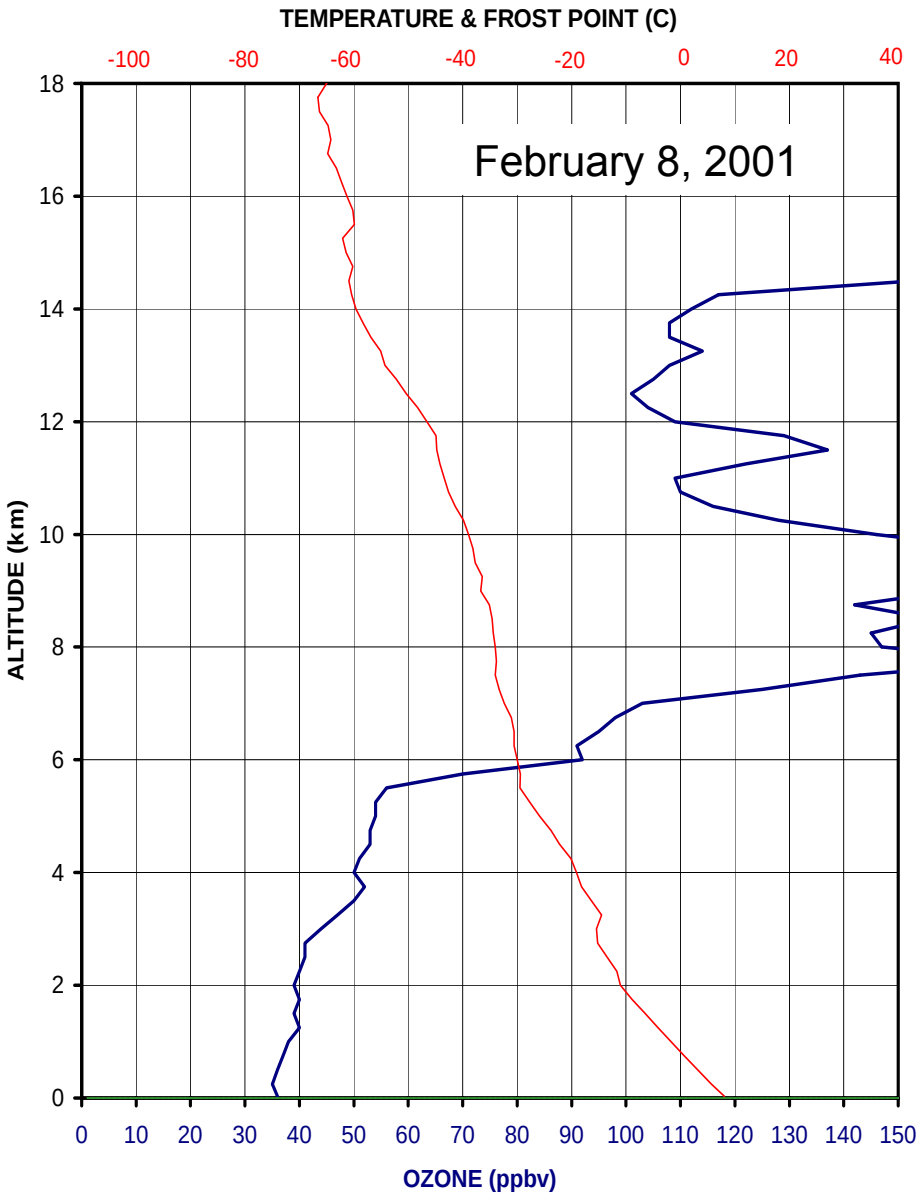


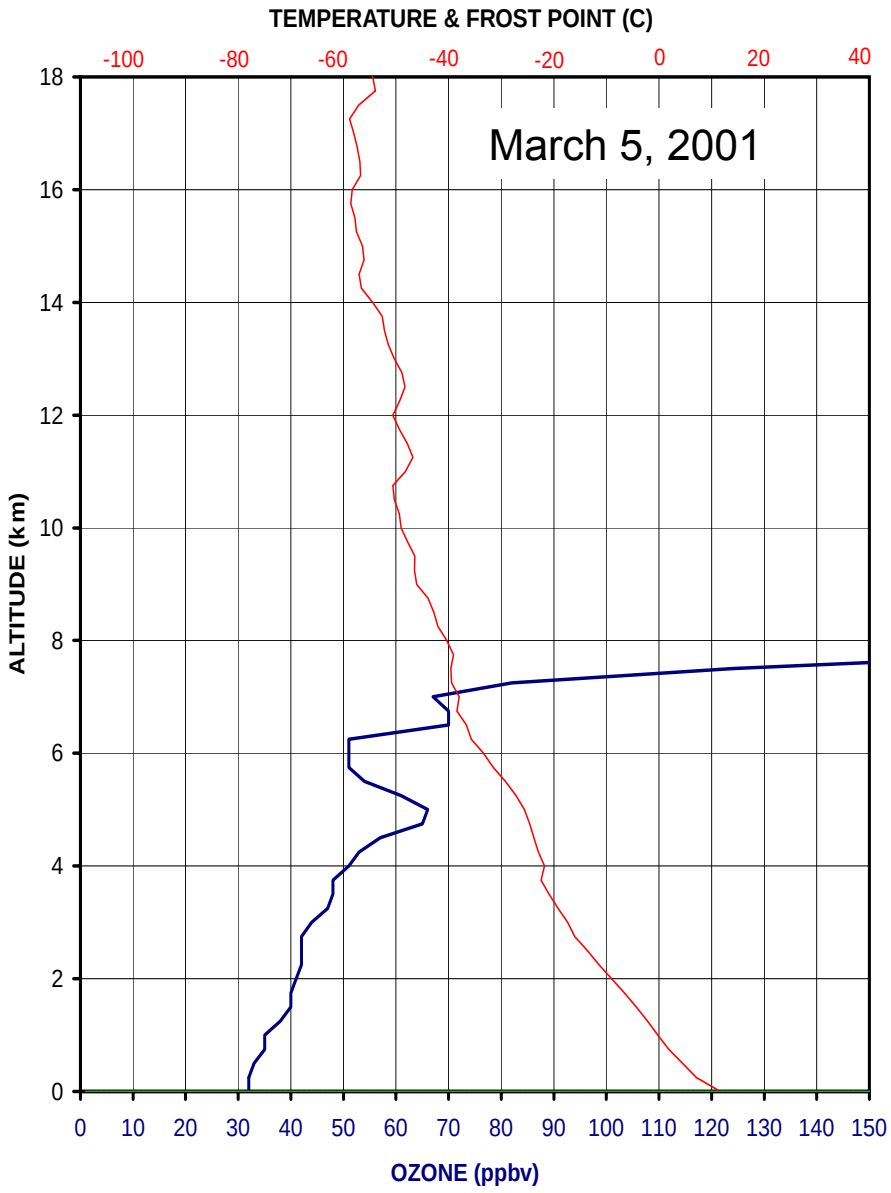
Average Ozone Mixing Ratio at Tateno (36N) and Sapporo (43N) for February – April 2001



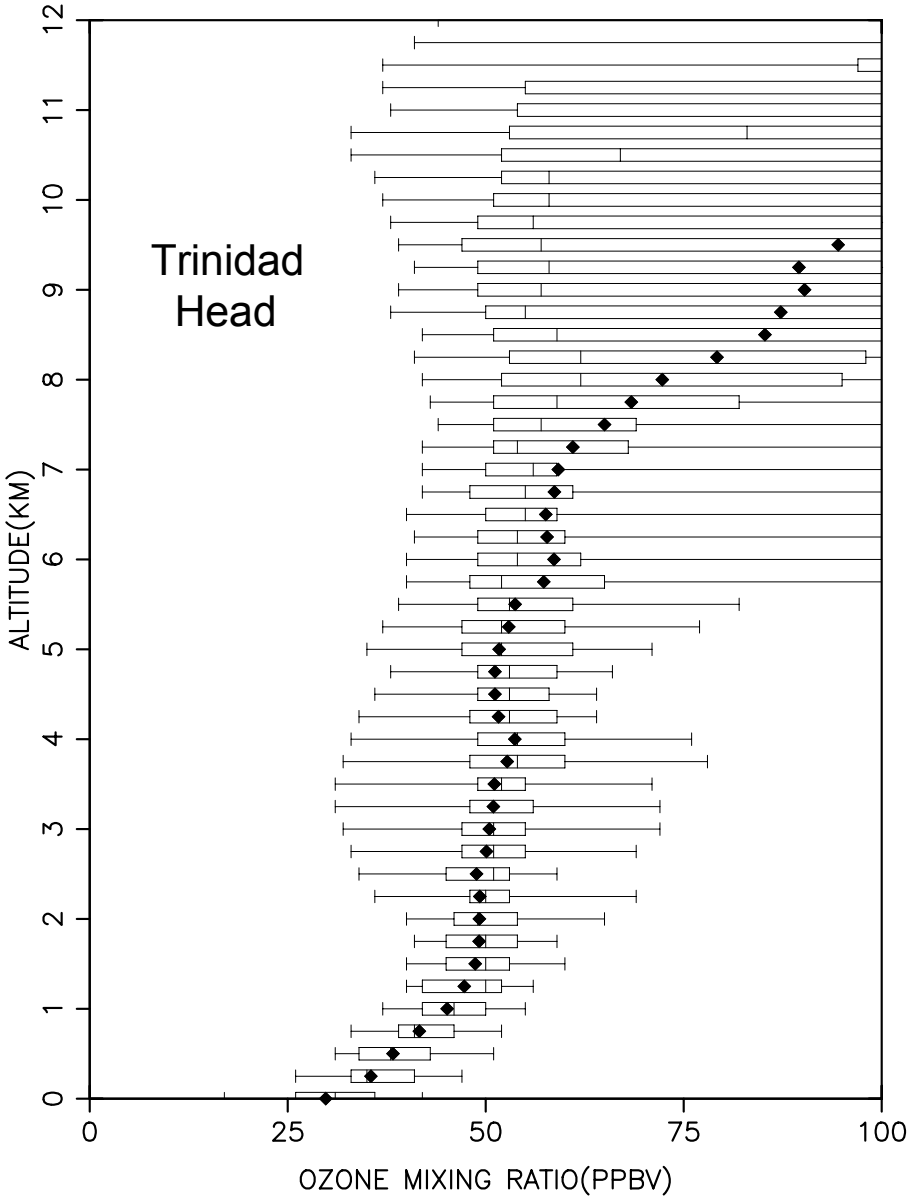


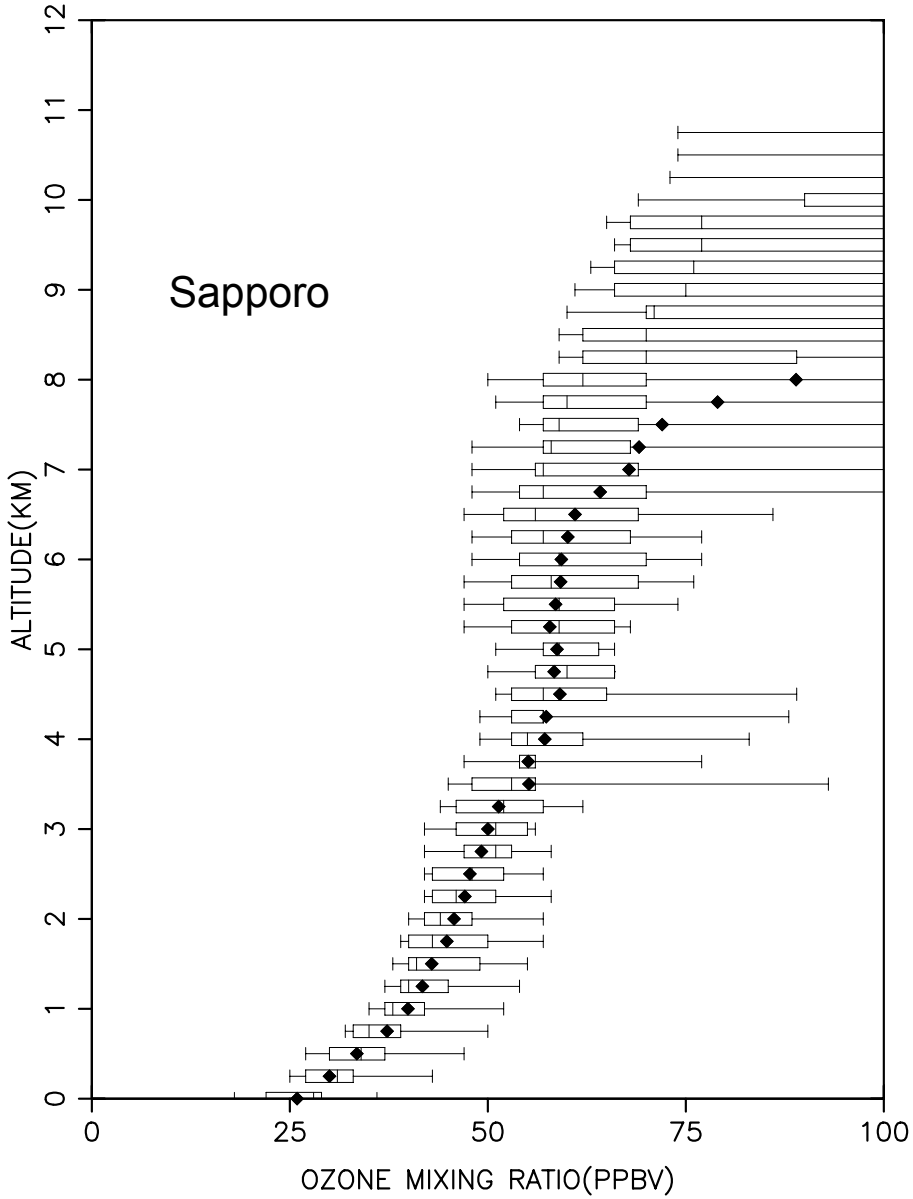
Ozone Mixing Ratio at Tateno, Japan (36N) on February 8, 2001 at 0530 GMT and March 5, 2001 at 0531 GMT



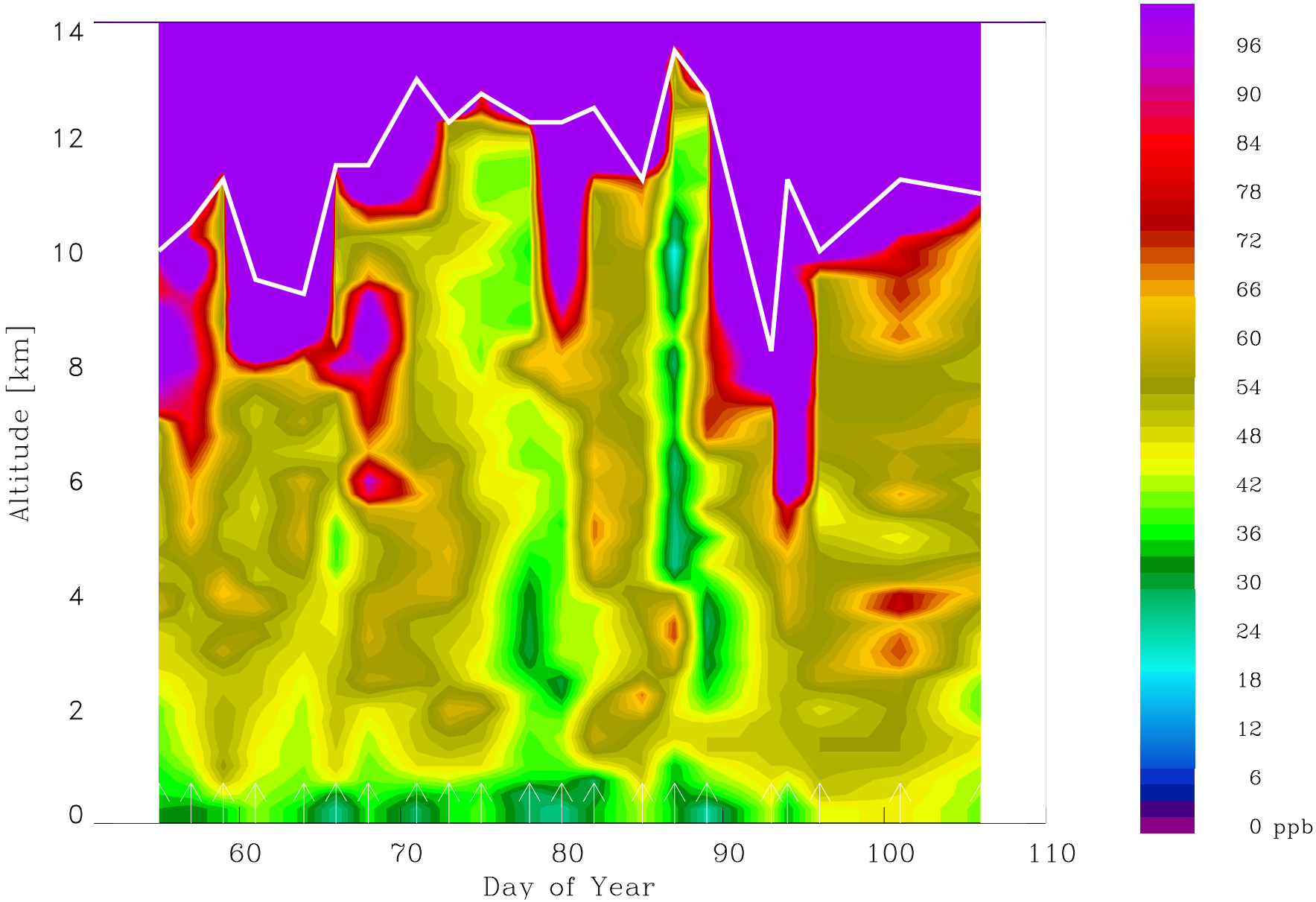


Average Ozone Mixing Ratio at Trinidad Head (41N) and Sapporo (43N) for February – April 2001

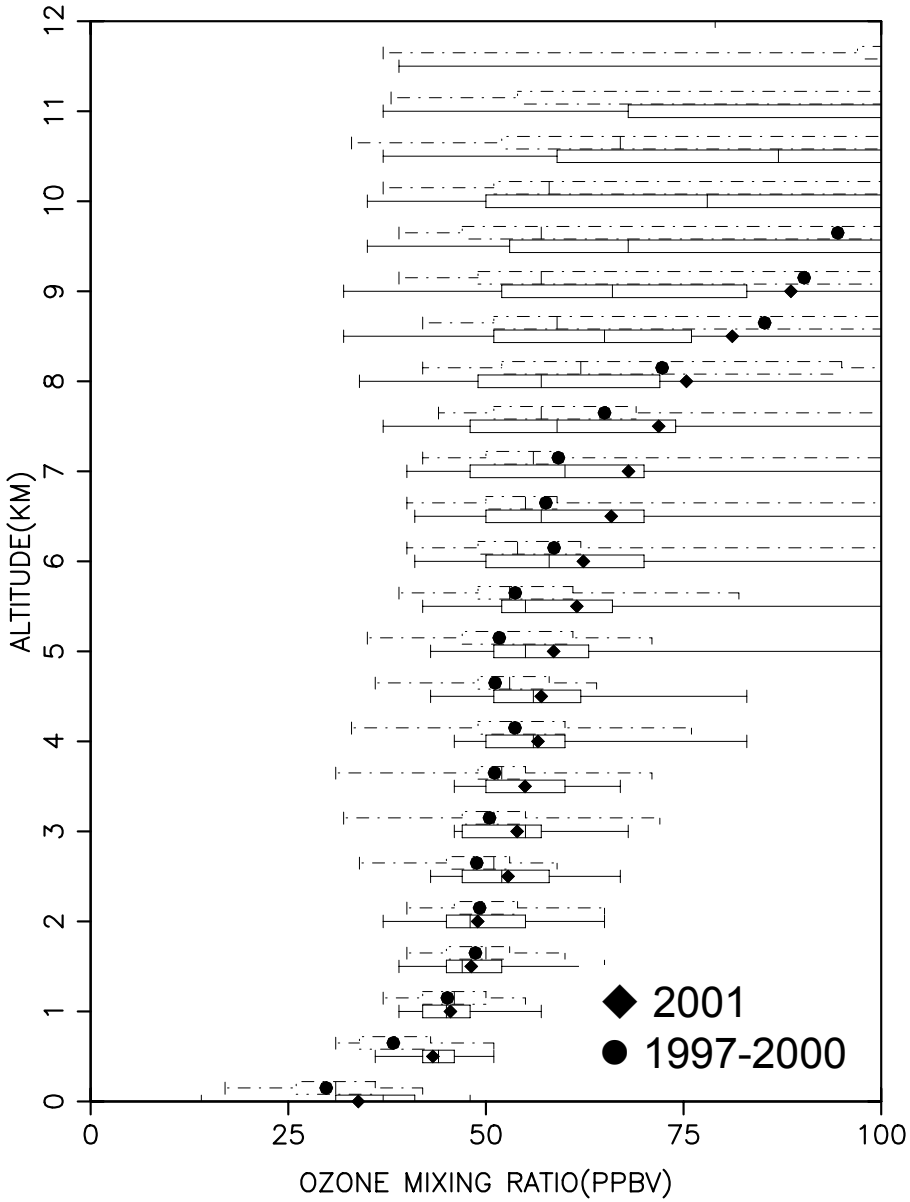




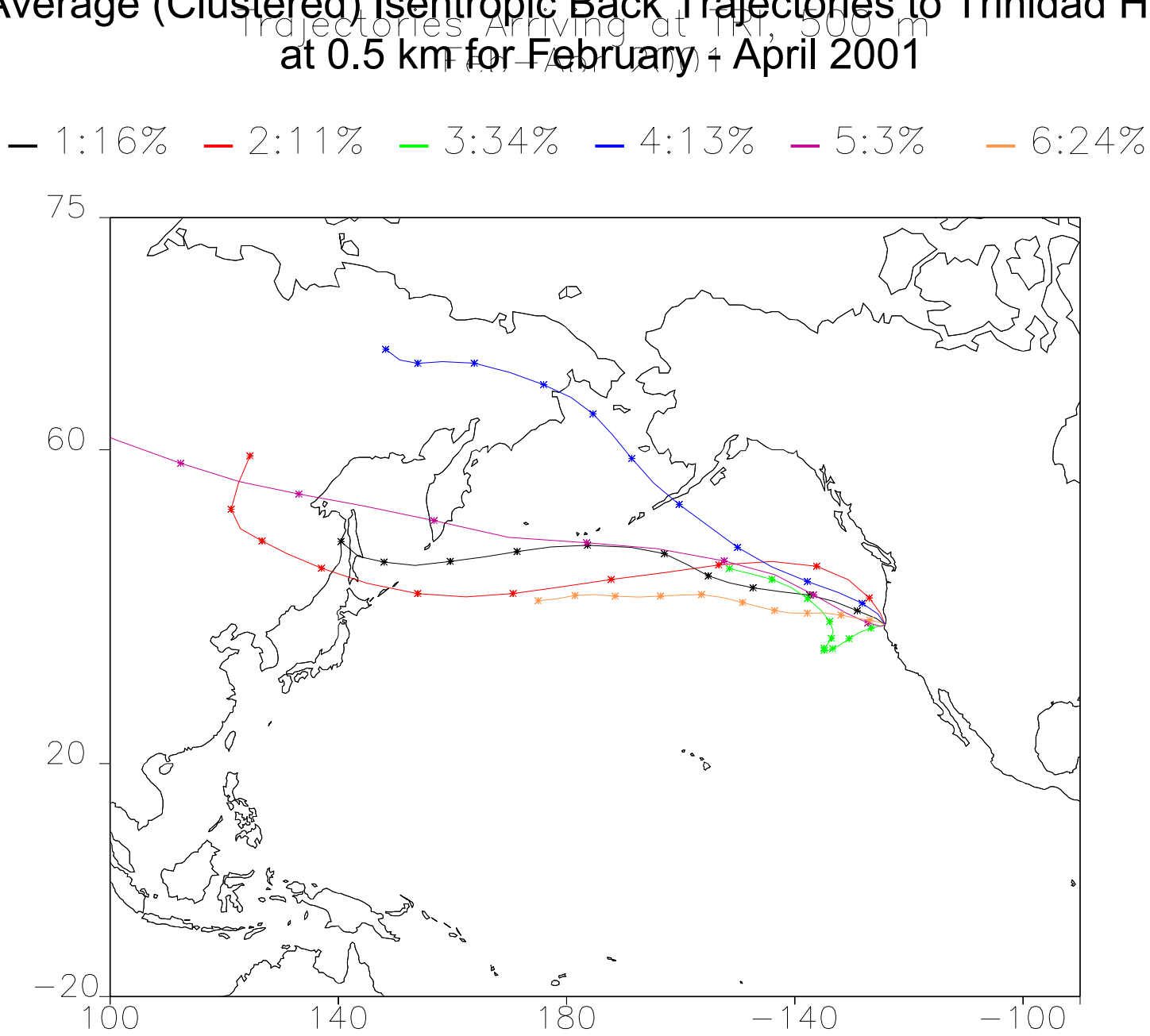
Trinidad Head, CA Ozone Mixing Ratio for February – April 2001



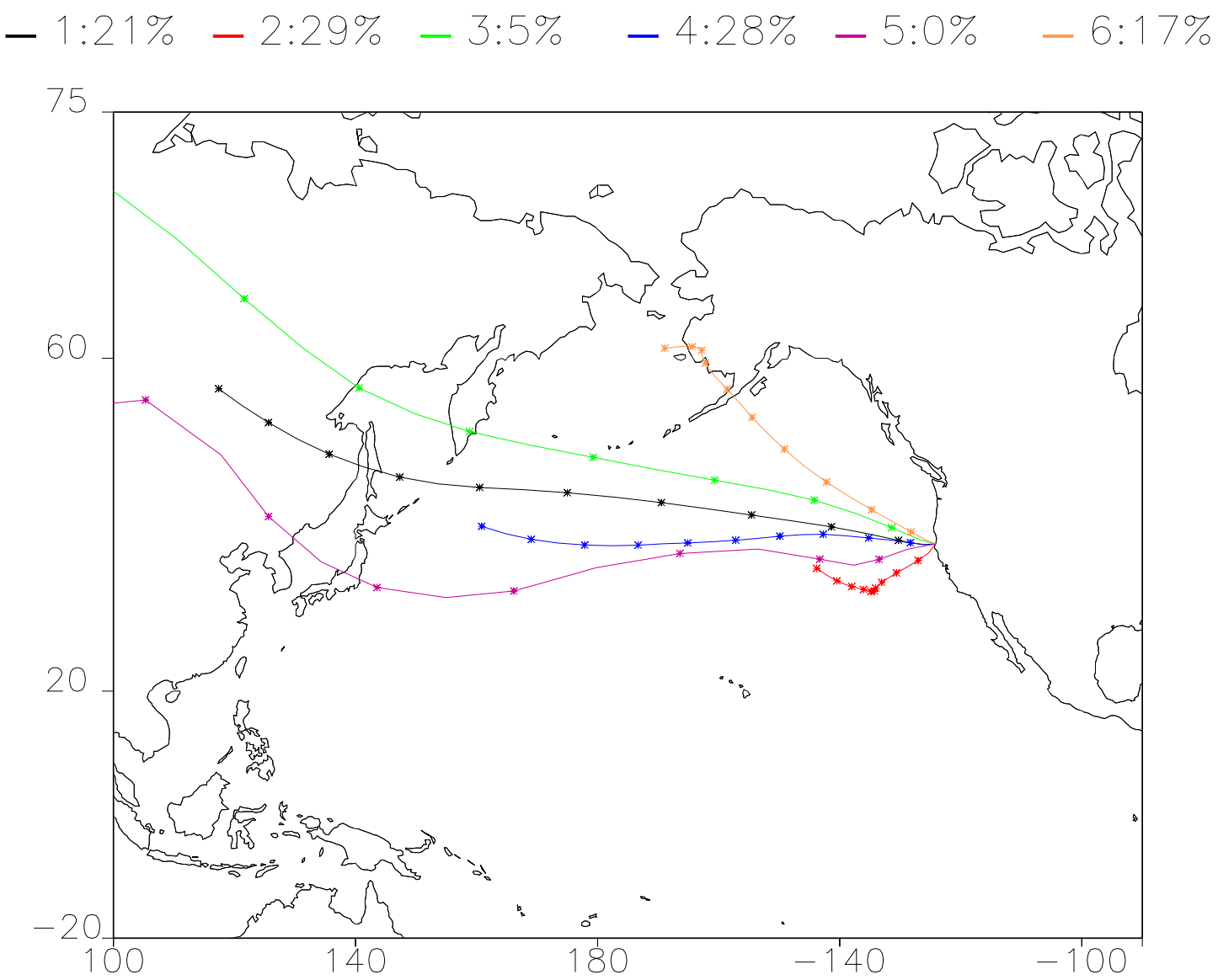
Trinidad Head, California Average Ozone Mixing Ratio for February – April 2001 compared with February – April 1998-2000



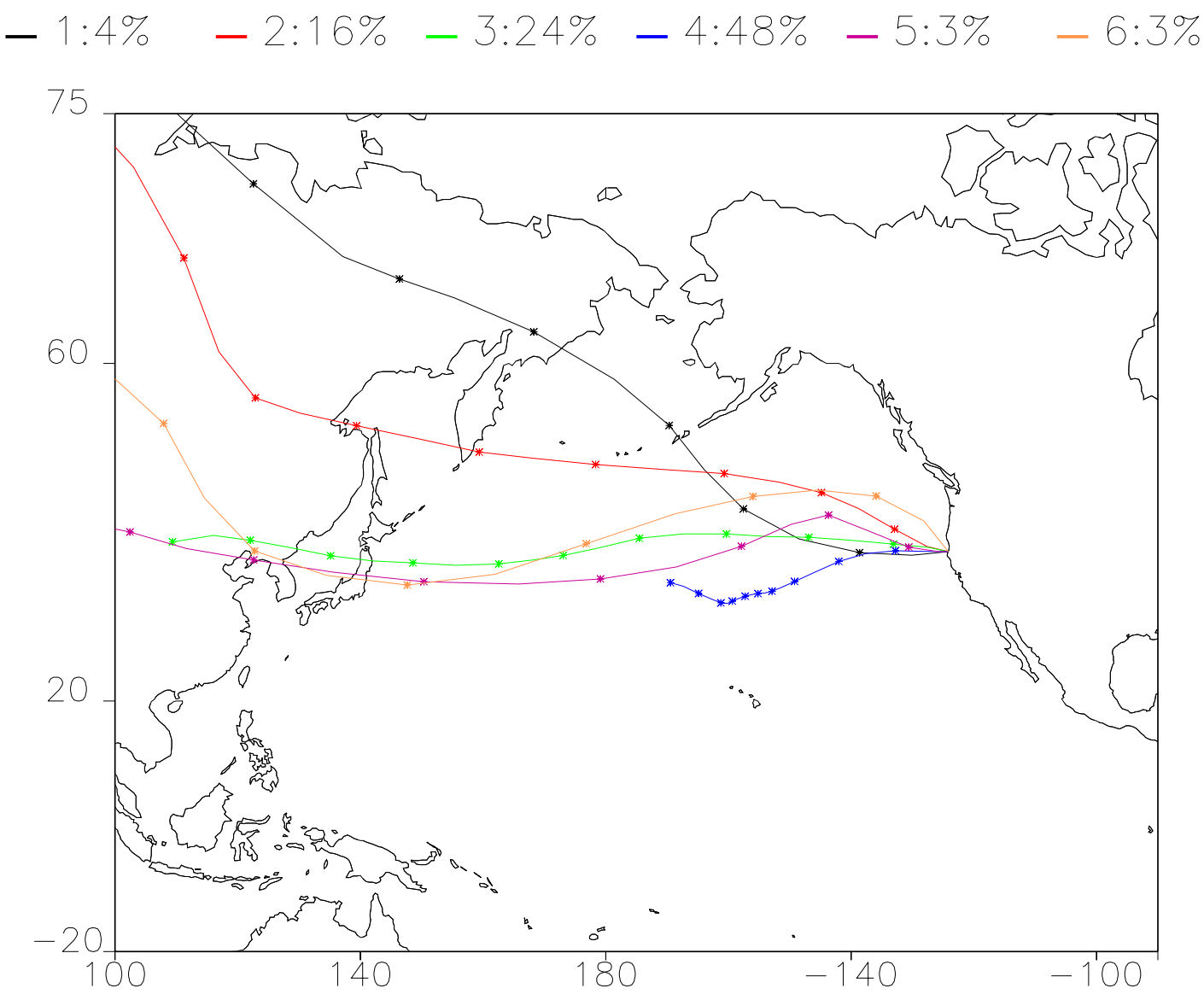
Average (Clustered) Isentropic Back Trajectories to Trinidad Head at 0.5 km for February - April 2001



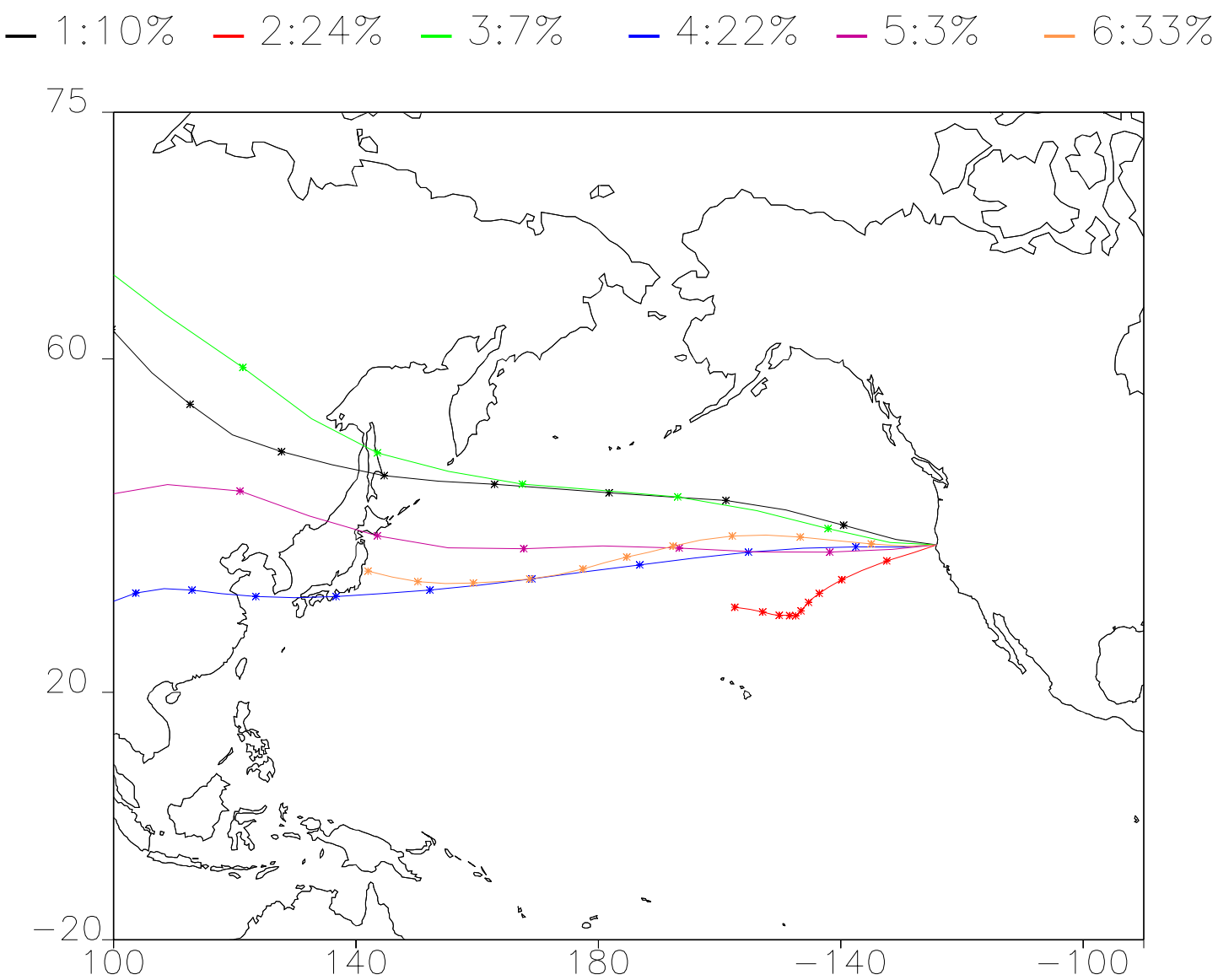
Average (Clustered) Isentropic Back Trajectories to Trinidad Head at 1 km for February – April During the Period 1990 - 1999



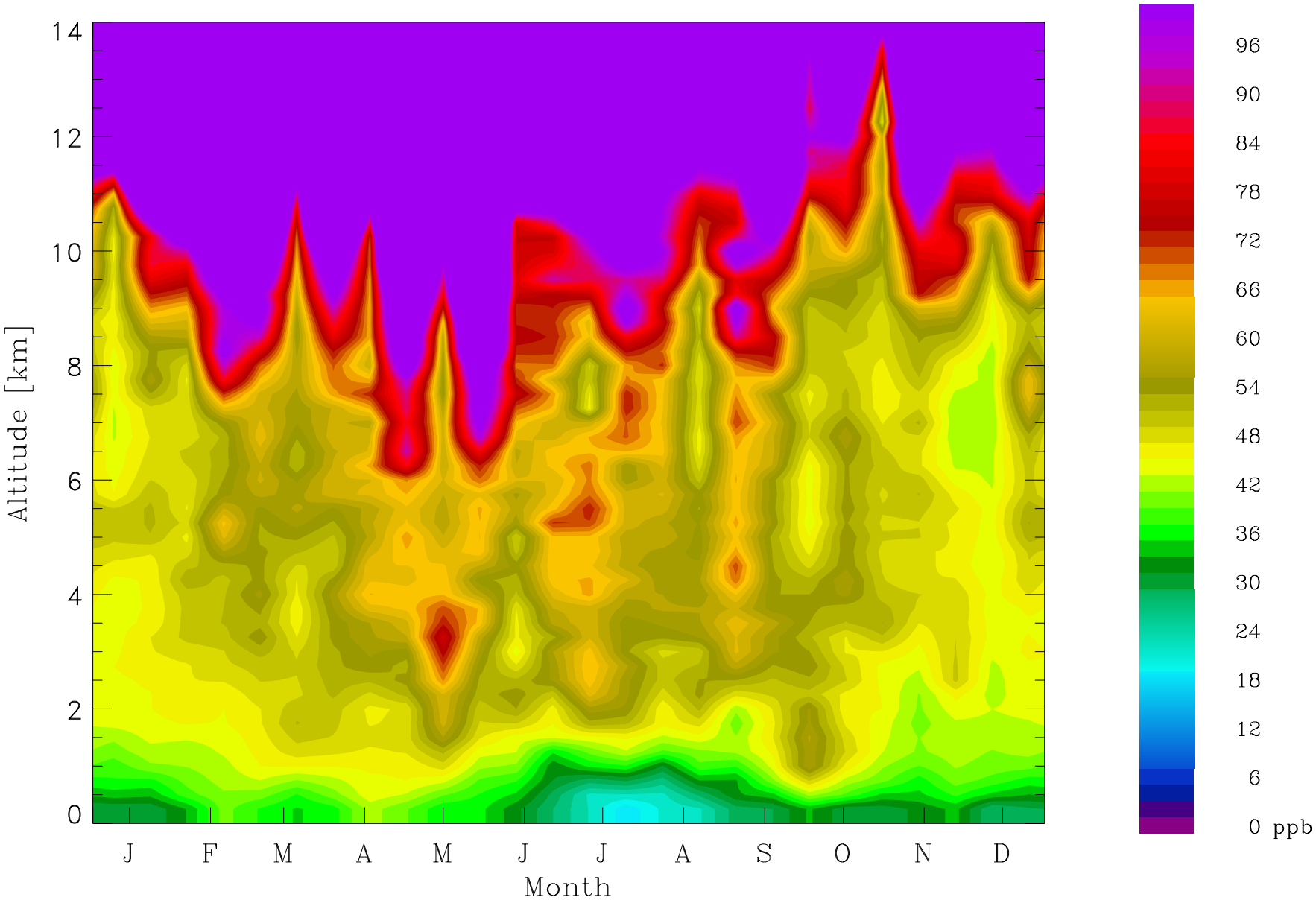
Average (Clustered) Isentropic Back Trajectories to Trinidad Head at 3 km for February - April 2001



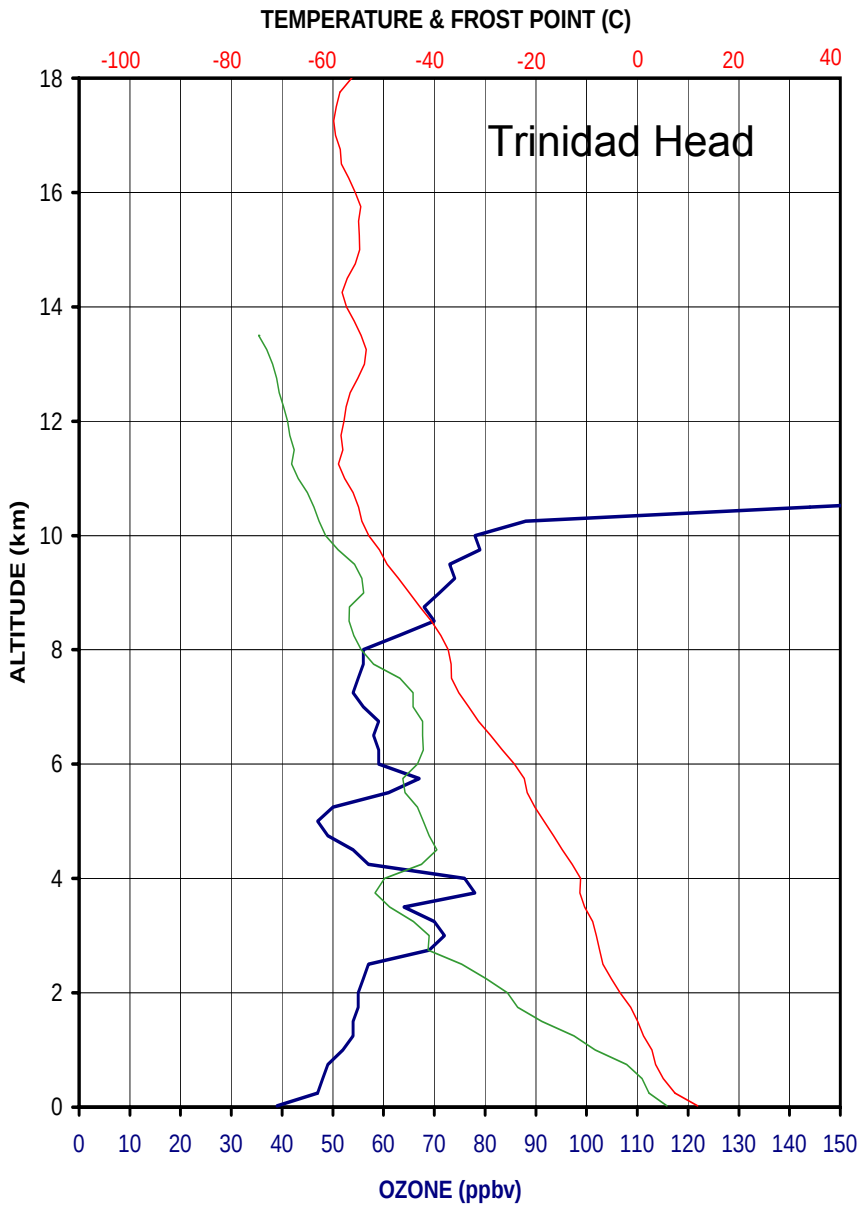
Average (Clustered) Isentropic Back Trajectories to Trinidad Head at 4 km for February - April for the Period 1990 - 1999

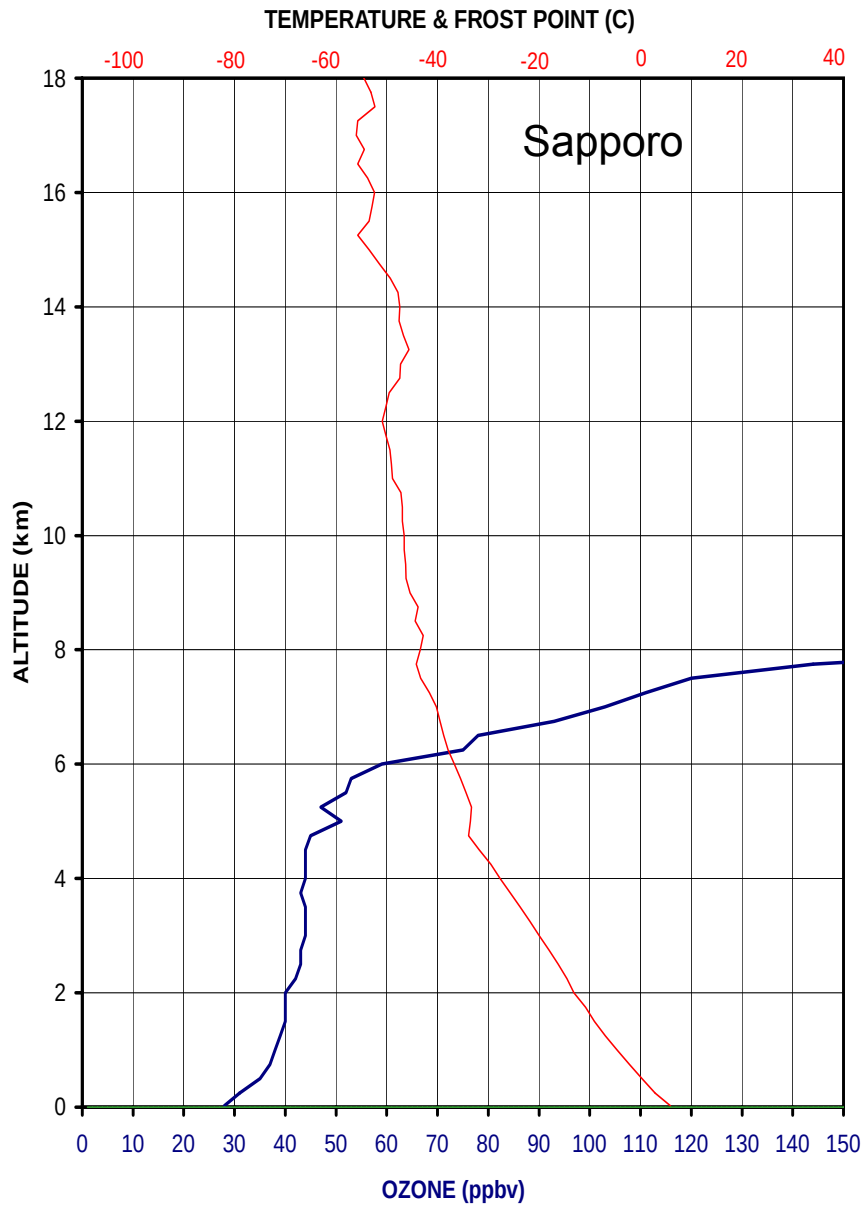


Trinidad Head, California Average Ozone Mixing Ratio (1997-2001)



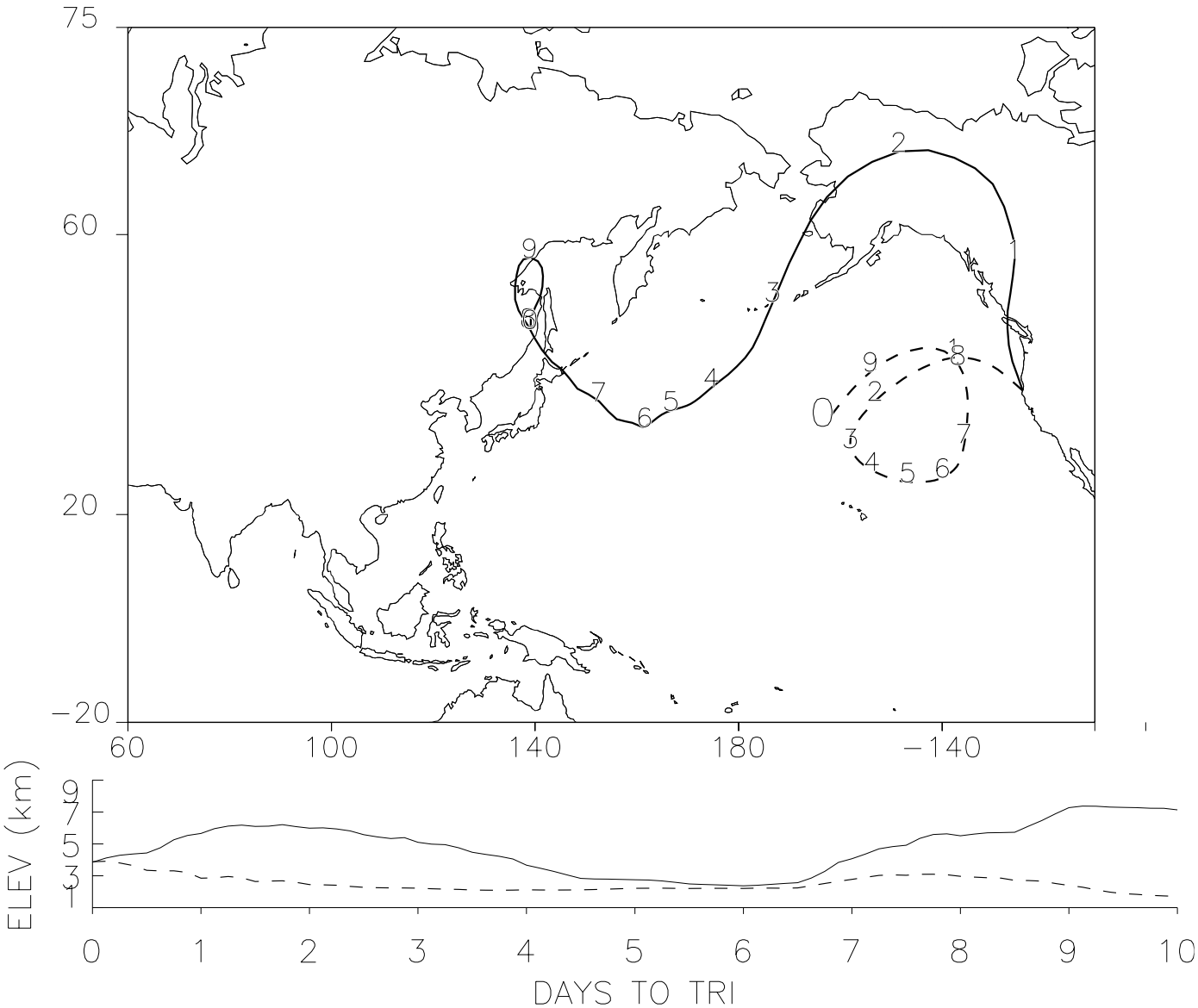
Ozone Mixing Ratio at Trinidad Head (41N) on April 11, 2001 at 1804 GMT and Sapporo, Japan (43N) April 11, 2001 at 0530 GMT





Back Trajectories to Trinidad Head on April 11, 2001 at 00 and 12 GMT at 4 km

Solid Line = 00 GMT Dashed Line = 12 GMT



Results and Preliminary Conclusions

- In the western Pacific south of about 35^{o}N there is more ozone in the lower troposphere (<5km) than in the mid-Pacific or higher latitude lower troposphere.
- At stations north of about 35 degrees the tropopause is often very low (6-8 km) and there are large tropospheric ozone amounts that appear to be associated with transport from the stratosphere.
- At Hilo, HI and Trinidad Head, CA the February – April 2001 period seems to have tropospheric ozone amounts that are similar to longer term average amounts (these are the only two stations where this comparison has been done).
- Hilo, HI (19.5N) has much more ozone in the upper troposphere during this time of year than do the western Pacific sites south of 30^{o}N.
- Western Pacific sites south of 30 N show a relative minimum in the upper troposphere.

Future Work

- Compare the February – April 2001 period with the longer term behavior for the eastern Pacific sites where there is a multi-year ozonesonde record.
- Describe the seasonal behavior of tropospheric ozone over the north Pacific (similar to what has been done at Hilo and Trinidad Head).
- Develop a transport climatology using isentropic trajectory analysis and link the transport patterns with seasonal ozone behavior over the north Pacific.
- Examine additional interesting ozone events in both the seasonal pattern and individual profiles using trajectories to identify possible tropospheric ozone source regions.

Trinidad Head, California Average Ozone Mixing Ratio